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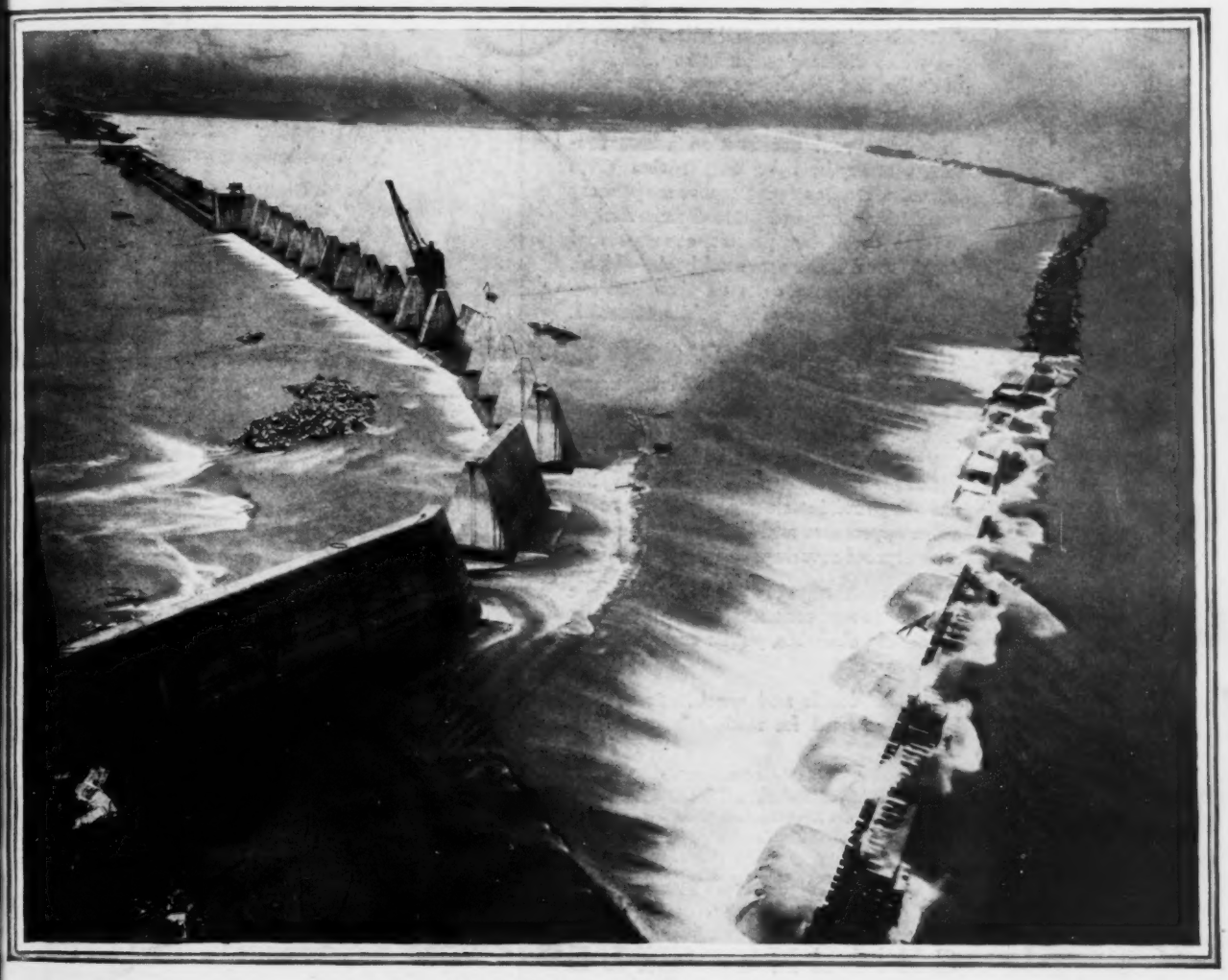

Cofferdam on the Ohio Topped by an 80,000 Sec.-Ft. Flood

Construction Plan and Plant at the Falls of the Ohio River

Designing the Carquinez Strait Cantilever Bridge

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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JAMES H. McGRAW, *President*
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FRANK C. WIGHT
Editor

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A Champion Fallen

LABORING to make building construction better—a ceaseless and sometimes almost hopeless task—has engaged many earnest workers through the long centuries, but few of them brought to their work the singleness of purpose and thorough devotion, even enthusiasm, that animated Ira H. Woolson. His passing this week in the midst of his activities means that the ranks of the workers are lessened by a strong and influential personality. One may think back three decades to his successful part in developing a fire test procedure which would shield the city dweller from disaster, or to the later period when he counseled cities and towns throughout the country in formulating safer building laws, or most recently to his crowning work as head of the Hoover building-code committee, which brought all the diversified building interests into co-operation in the approval of model building regulations—in each instance we see him as a leader of the fight, a figure distinguished by courage, truthseeking and clear vision. The work must go on without him. Let us hope that others will take up the work he laid down and bring to the task equal gifts and equal strength.

A Notable Contract

IN SOME respects the contract let last week for the New Jersey piers of the great Fort Lee bridge over the Hudson River is easily the outstanding item of recent contracting. For one thing, it is the first test of how well the Port Authority's operations can proceed smoothly in spite of the threat of political interference presented by the law passed by New Jersey a few months ago giving the governor a veto over the Port Authority contracts. In this instance the result is reassuring, but obviously it is not a guarantee against harmful exercise of that veto power in future, and the more serious test is therefore yet to come. The contract is even more interesting, however, in respect to its substance. The open cofferdam process is to be used in very soft ground, to construct a foundation at a depth of about 75 ft. to rock, and the cofferdams will be of large size, approximately 100x110 ft. This is by far the most ambitious piece of construction of its kind ever undertaken. A cofferdam of nearly the same area has been carried down to rock about 45 ft. below water at the Arlington Memorial bridge in Washington recently. The work there has been highly successful, and presents a gratifying demonstration of what may be accomplished with heavy steel sheeting well set and maintained. With this precedent, success and rapid progress in the Fort Lee work may be anticipated, especially in view of the ability and experience of both contractors and engineers engaged in the work. Almost equally noteworthy as the natural conditions and the method is the rapid rate of working that is specified. The piers are to be completed up to low water by winter, so that a single working season must suffice for carrying down two very large and hazardous pieces of excavation, and constructing in them huge concrete piers nearly 100 ft. high. Here again the expectations are for entire success. But to give due credit in advance, it will be a distinguished achievement, and the work will put on record a new precedent in foundation work, likely to stand as a model for a long time.

England Moves Against the Strike

LAST year's abortive general strike in England is having its legislative aftermath. The so-called Trades Union Bill, now before the House of Commons, is a direct result of that strike, and its success or failure will mark the real effect of the strike on British polity. The Conservatives, the party in power, are trying to enact this law against the open opposition of the Labor party, to whom all of its provisions are anathema, and against the faint objections of the Liberals who for political purposes can hardly agree with anything the Conservatives propose. Which will win cannot be forecast this far away, but win or lose it is a mile post in labor legislation. For this bill does what has not been attempted before in liberal minded countries, it by law limits the right to strike, and punishes those who violate its provisions. No strike is allowed except within the limits of a particular trade which has a real grievance, picketing is made unlawful, strike funds must be accounted for and used only for certain purposes, and forced contributions to unions are prohibited. All these provisions, it will be seen, are aimed to prevent by law that kind of general strike which last year failed of its own weight. If such a bill can become law, and can be enforced, England has stopped for a while her rapid march toward a government of, for and by the man who works with his hands.

Cleveland Gets the Road Show

IN PARTIAL answer to the demand that the Road Show be moved East the directors of the American Road Builders' Association have selected Cleveland for next January's show and convention. There was no other place which could be selected—except Chicago. A thorough canvass of the country showed only two halls large enough to house the great aggregation of road building machinery that is brought together every year, the group at Cleveland and the huge machinery building at the Sesquicentennial at Philadelphia. But the latter is not heated, an absolute bar to its use in January, and no assurance could be obtained that heat would be provided. The board, therefore, fell back on Cleveland where the exhibition space is ample but where the hotel capacity is somewhat subject to doubt, though local enthusiasm discounts this objection. Chicago has had

the show for a number of years, and every one knows what the conditions there are. The Coliseum has become impossibly crowded. Since the object of the show is to permit prospective users to inspect machinery and not to test the capacity of an exhibition hall it will be worth trying for one year the experiment of giving ample space to the exhibits even though possibly not quite so many may crowd into the hall. And if the experiment proves successful there is the possibility of extending it further and moving really East a later year.

Planning For Flood Flows

AT THIS time when the high water in the Mississippi and its tributaries is engaging so much of public interest the article in this issue on the construction work for the Louisville powerhouse and dam is peculiarly timely. For this article reveals what careful planning is necessary in dealing with construction in and about these rivers subject to great and rapid changes of level. This is common enough in any river or stream work but few engineers have to plan construction in a river that may rise and fall 50 ft. in a season and may in addition pass nearly a million second feet of flood flow. The construction operations at Louisville were well thought out and well executed, but the outstanding feature of the work was the study that was put on the probable behavior of the river and the design of the protective works and the arrangement of the course of procedure to meet the conditions of river flow that was, by the best scientific predicting, bound to happen. The construction is not yet completed but its course to date has amply justified the care taken to insure its successful termination.

Future Hazards

RECENT years have brought us face to face with many surprising manifestations of nature's powers of destruction. Storm, flood and earthquake have been active in turn. Whenever man is about ready to sit back and say contentedly that he now feels able to defy the forces of nature, some new "act of God" overthrows his complacency. And coming unexpectedly, without warning, every happening of the kind constitutes a fresh indictment of our lack of foresight, and makes a new demand for better preparation against future hazards. So it is quite fitting that, at the very time when the greatest flood is sweeping the Mississippi valley, while a crop of tornadoes has wrought ruin in the Southwest, we should give attention to the fact that students of earthquakes have been meeting at Cambridge, and have directed renewed attention to the existence of a potential earthquake hazard in regions that we are apt to think of as dependably quiet.

Probably nothing else in the range of known earthly facts can wreak destruction so widespread and universal as earthquake shocks. In the older parts of the world, we are led to believe, great cities or entire provinces that flourished for centuries were laid low by earthquake in past times, some of them never to rise again. On the Western Continent we have no such long perspective of experience to guide us. The whole time of American history is very short, and opinions or convictions based on that limited experience can have but little weight. The conclusion of scientists, such as the Cambridge group, that New England (and no doubt many other parts of the United States) may at some time be subject to a heavy earthquake is for this reason to be taken more seriously than if there were the history and tradition of some thousands of years to refer to, as a check on our construction practices. For, to a much larger extent than our ordinary thinking is likely to concede, the practices of engineering construction as well as of ordinary building rest on the empirical basis of actual past experience in the particular region of the earth in question.

An element of panic is apt to be connected with thoughts of earthquakes, and tends to interfere with well directed analysis and planning. Twenty years ago the after effects of such panic caused San Francisco to euphemize its earthquake into "fire," and in the same psychology Los Angeles looks with disfavor on too close public attention to its own occasional earth vibrations. Because of this psychology, such matters as estimating the probable earthquake chance and planning definitely to meet the hazard by adequate construction have received far too little attention in the past. But, unless the prevision of the scientist is quite wrong, these matters are due to receive more attention in future.

One of the interesting evidences of a new and energetic attitude toward earthquake possibilities is an extensive survey of buildings, carried out within the last year by California underwriters. Several thousand buildings were embraced in the survey, and much thought was given to estimating all the probable factors of construction that would tend to increase or decrease the amount of loss in a severe earthquake. Without such an analysis, obviously insurance against earthquake could not be conducted as a sound business, though strangely enough an extensive business of the kind has until now been going on, on this unguided basis. In some other parts of the country earthquake insurance has been receiving consideration where it previously had been given no thought, and it is natural to suppose that similar structural survey work will be necessary quite generally in order to furnish a proper basis for rating this insurance.

In the field of construction, the earthquake hazard also is receiving increased attention. What is perhaps the most remarkable piece of earthquake-resistant planning that has yet been done is that of a building now under construction in Tokyo, a structure designed to give complete structural safety in the most severe earthquake to be expected in that unquiet country. There is bound to be great interest in the details of this structure, publication of which is promised for the near future. To what extent the thorough planning done for Tokyo conditions will find proper application in the United States is a question that still remains to be answered.

The civilized life of modern times rests almost wholly on structures and services that may be disrupted by earthquake forces. Probably at no time in the world's history did the conditions of life make such large masses of people dependent on centralized supplies as now, or make the risk of earthquake disorganization so great. This factor must inevitably be taken into account, together with the actual nearness or remoteness of earthquake danger, in shaping the attitude to be taken toward this hazard. We live under new conditions, and the speculations and forecastings of scientists with respect to earthquakes correspondingly have a new importance. Such facts and reflections as were advanced in the Cambridge meeting are therefore of universal concern.

Appoint an Engineering Commission

PUBLIC opinion needs a widespread appreciation of the details of a great calamity to make it take seriously the warnings of experts. A typhoid epidemic is the one sure incitement to an improved water supply, a destructive hurricane can do more for better building laws than a hundred engineering reports. What has not happened probably never will happen, the public thinks, but once it has happened horror at the event joins with wonder that what the few predicted has really come to pass and the public mind rushes unanimously toward a prevention of a recurrence of the event.

Just now we are in process of the development of such a state of mind toward the Mississippi. For some reason not precisely explainable the country is in what almost approaches hysteria regarding the Mississippi floods. Floods have occurred before on the Mississippi, the two most recent, indeed, closely approximating this one in extent and in hardship to those in the flooded areas. The 1927 flood differs from those of 1913 and 1922 only in a foot or two of flood height at certain points and in the extent of the tributary river area inundated. It is doubtful if the flood flow or the losses are much greater. But the country is aroused as it was not in 1913 or in 1922. Millions are pouring in for relief where thousands came before, and demands for cure of the evil fill the newspapers from Seattle to Jacksonville where before the average citizen outside the valley hardly knew a flood was on.

Whether this excited interest is due to the well press-agented efforts of the American Red Cross or to the personal concern of Secretary Hoover is beside the point. Neither would it be proper to discount the horror of the inundation. Thousands of people are homeless, millions of dollars worth of farmland is temporarily rendered worthless, hunger and sickness are widespread. But it is important to record that this has been the common experience of a dozen floods and that up to now the nation at large has taken but little interest in the fact. Because of this astounding reaction to a familiar situation we are now in prospect of a favorable response to the oft-repeated cry for a comprehensive and expensive program for protection of the Mississippi valley against these repeated inundations.

Except for the fact that possibly by December the country will have resumed its lack of interest in the Mississippi flood control, it is a good thing that Congress is not now in session. With the country-wide emotional uplift now on a rising wave it would be a hard-hearted Congress that could resist the impulse to do something and to do it quick, with the natural result that it would be rushed into a plan of relief conspicuous mostly in the fact that it was a plan rather than it was the right plan. By December the emotion will to a degree have subsided—let us hope not too far—and Congress can consider the whole question of national flood control soberly with due regard to its national implications outside the Mississippi valley.

For the Mississippi flood problem has two phases, that of national responsibility and that of physical control. The first is distinctly the problem of Congress, the second, while the ultimate responsibility of Congress, is the problem of the engineer.

Congress will need a long time for thought, for debate and for inquiry before it can decide on the question of who shall pay for the complete control of the swollen rivers that lay temporary waste on so large an area of our country and to decide further whether that particular section which takes the flood flows of our central basin shall have consideration above other sections that also are in the trough of extended drainage areas over which they have no control. No national problem has greater importance and to no one is there less real background of precedent or concerted thought. By next December there ought to have been formulated enough programs so that Congress can approach the problem with assurance of proper consideration.

Meanwhile there remains the engineering problem. For fifty years that has been the constant study of a few engineers, and as a result of that study the current plan for controlling the river has been formulated. As was stated in these columns last week, there are many who disagree with that plan. Some of these are reasonable critics, with knowledge of hydraulics and of this river as their guide; most of them are amateurs or cranks, with the faculty of engaging the popular ear and fancy. It is the manifest duty of the government to take this combination of knowledge and theory and to try to evolve therefrom a consensus that approaches, at least, a solution of this stupendous problem. Here it would seem is the opportunity of the President. For six months he represents, alone, the United States government. Congress, if called in special session, would be apt to be stampeded into unwise action, and even when it meets it will not be able to decide the technical aspects until it receives due professional advice. But the President can, in those six months, prepare to furnish that advice, through the appointment of an engineering board to report to him for submission of fact to Congress.

Such a board should comprise more than the Mississippi River Commission. Already the President has called upon that body for a report, through the Chief of Engineers, who holds veto power over its acts. That commission contains the best knowledge of the behavior of the Mississippi that exists; all of its members, civilian and military, have spent a large part of their professional life on the river, and collectively it has a background of experience which constitutes a reservoir of information that can not be spared in this study. But the commission is committed to a plan. In general, it has the only comprehensive plan that has ever been suggested by any one qualified to have an opinion. But the time has come when this plan must be submitted to expert criticism, when it must be approved or amended by those competent to understand its technicalities.

The President should appoint at once an engineering board on which the Mississippi River Commission is represented but which it does not dominate, and that board should proceed to as thorough a study of the Mississippi River problem as six months' time allows. There is enough engineering talent in the country to guarantee authoritative consideration of the question and to carry weight to Congress and the country when once it has reported. It is not enough merely to ask the Mississippi Commission to report, or even to appoint, as the President is reported to have done, a cabinet and congressional committee to study the matter. This is an engineering problem, and it needs engineers to solve it. The profession is under more-or-less veiled attack for not having solved it by now. It is entitled to representation in the national inquiry that should be started.

Construction Plan and Plant at the Falls of the Ohio

A 100,000-Kva. Development of Power Worked Out in Connection with Dams for Navigation In a River Varying in Flow from 5,000 to 800,000 Sec.-Ft.

FITTING a construction plan to the hydrograph of a stream with wide extremes of flow and large variation in stage has been the big problem in building the new hydro-electric plant at the Falls of the Ohio at Louisville, Ky. At this point the flow ranges from 5,000 to 800,000 sec.-ft., with floods of 150,000 sec.-ft. or more occurring on the average several times during the year, and lasting from one to three months. The observed variation of stage has been as much as 65 ft. Also, here in a distance of three miles there is a drop of 25½ ft. Elsewhere from Pittsburgh to Cairo the slope at low water averages less than a foot a mile. The river is being improved for slack water navigation by some fifty dams and accompanying bypass locks, the work being scheduled for completion in 1929. One of the dams, No. 41, with a crest elevation of 414 ft., an upper pool level of 412 ft., and a lower pool level of 383 ft., is at the falls. Thus the conditions affecting power development were: A low head, floods which for days in the year completely wipe out this head, an extreme

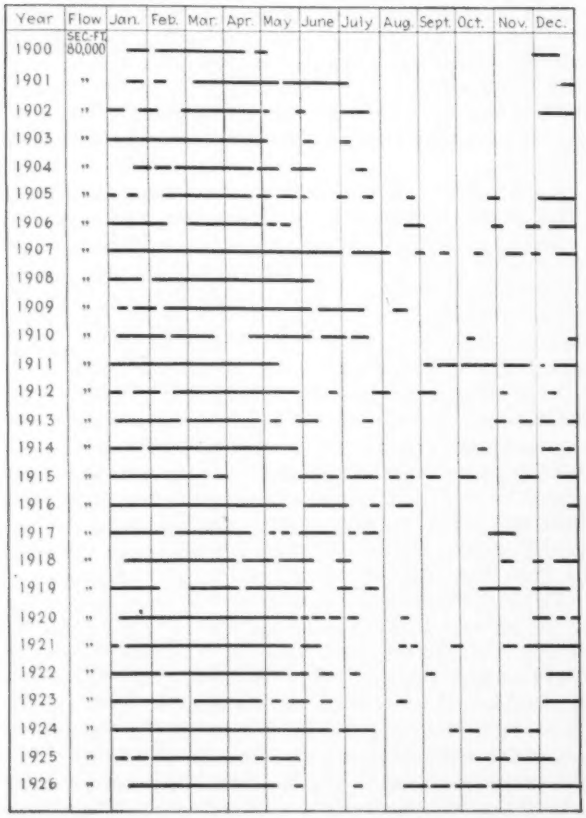


FIG. 1—PERIODS IN YEAR DURING WHICH FLOW EXCEEDS 80,000 SEC.-FT.

high water stage, and navigation structures to be coordinated with any power plant plan.

Under these conditions, engineering studies by the Byllesby Engineering & Management Corp. of Chicago indicated that power development was practicable (1) if there was a market which could absorb 75 to 80 per cent of the power generated and (2) if a pool level of 420 ft. were possible so as to increase the maximum head to 37 ft. The rapid industrial growth of Louisville promised the market and the U. S. Army engineers were

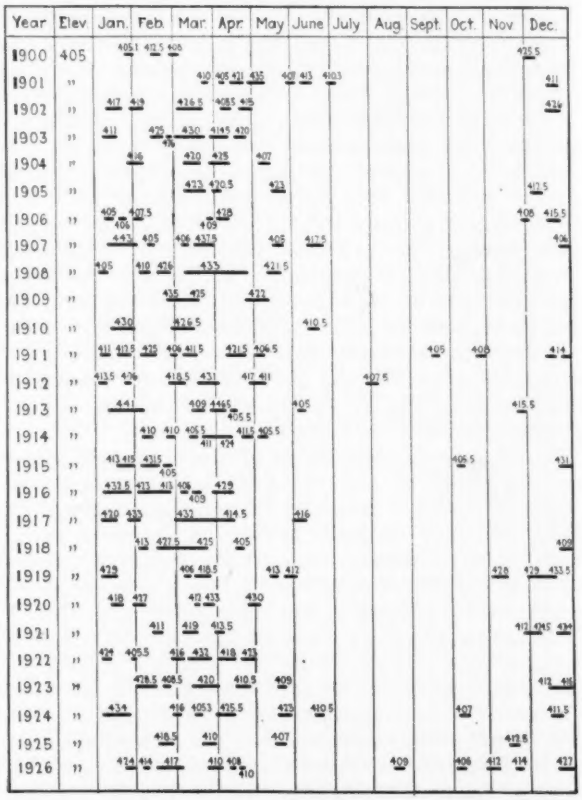


FIG. 2—PERIODS OF YEAR DURING WHICH COFFER IS OVERTOPPED AT EL. 405

found ready to co-operate in an arrangement for an increased pool level. The arrangement was completed in 1925, and provided for building a new dam No. 41, with a crest elevation of 422 ft.; eliminating dam 40, and extending the pool level of dam 41 back to dam 39. The full plan, then, as developed called for a dam 8,650 ft. long with a powerhouse 534 ft. long between one end and the Kentucky shore, all to be constructed in a stream of the unstable regimen of flow above noted.

Stream Control—Construction in the stream bed involved cofferdamming. Obviously, with the stream conditions indicated, cofferdamming to protect the work under all conditions was impracticable. Indeed, this is seldom the practice on Ohio River construction; the custom is rather to protect the work against low water and up to a certain economic high-water stage determined by conditions, and then let the work flood and stand idle till falling waters make the cofferdams again effective.

Exactly this practice was necessary in the power plant work. The best height of dam was the question. Two

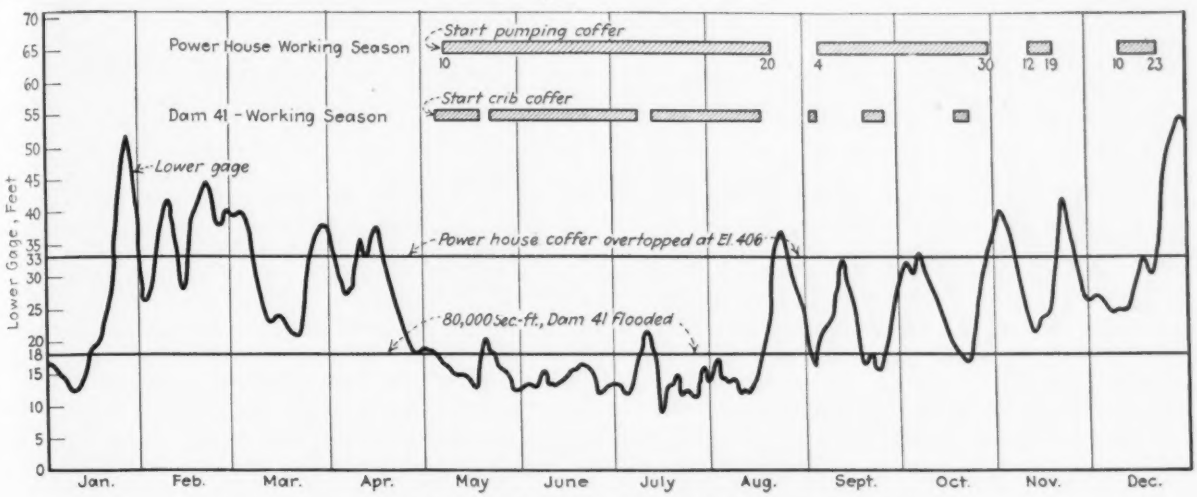


FIG. 3—HYDROGRAPH SHOWING WORKING SEASONS FOR 1926

things had to be regarded: (1) The higher the coffer was, the longer the working season would be, and (2) the lower the coffer was, the less would be its cost and its chance of being broken by flood. Integrating these factors with the amount of work to be done in each locality, its character and details, and the range of stage and discharge in the portion of the river concerned, led to the conclusion that maximum economy and efficiency would result from cofferdams sufficiently high to guard against discharges of 230,000 sec.-ft. at the powerhouse and of 80,000 sec.-ft. at the dam. When either figure was exceeded, the corresponding work would be flooded and interrupted.

Based on the records for 26 years, graphs were prepared as indicated by Figs. 1 and 2. Broadly, they indicated a prospective construction of six months annually in the river bed. Specifically, it was figured at the coffer heights adopted that at the powerhouse there would be a working season of six months with possibly one or two interruptions and at the dam a season of five months. The actual conditions of 1926 are shown by Fig. 3. This year, as will be observed from Figs. 1 and 2, was comparatively a bad year for construction on the Ohio. This fact is to be noticed because it indicates the uncertainty which confronted the engineers in scheduling construction and the leeway which had to be

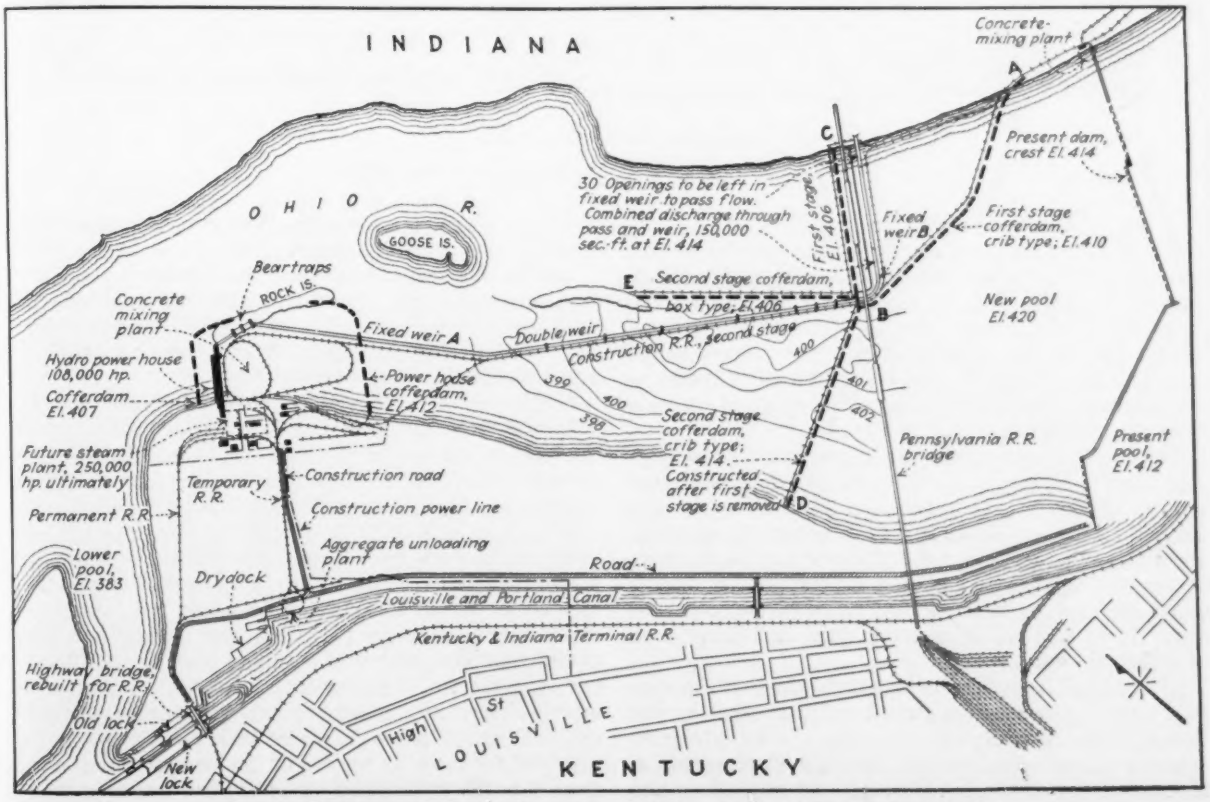


FIG. 4—CONSTRUCTION PLANT LAYOUT, OHIO FALLS POWER DEVELOPMENT

allowed in considering the time element of the construction operation.

The planned completion at the end of 1928 of the government's navigation works from Pittsburgh to Cairo virtually fixed this date as the latest for the completion of the power plant. The agreement for the changes in dam 41 was reached in September, 1925. With two months of the low water season still remaining in 1925 it was figured that with normal river conditions the two seasons of 1926 and 1927 would complete the river-bed work and the work unaffected by high water could be done in the remaining months. This was the time period for which plant and schedules were planned, leaving the season of 1928 to make up delays or for any final tasks that might come up.

Plan of Structures and Quantities—The location of dam and powerhouse is indicated by Fig. 4. This location of the dam was selected (1) on account of the advantageous conformation of the river bed and the good foundations, (2) because it promised the greatest ease of handling the river during construction, and (3) because it allowed for the requisite long movable dam to pass the regular floods. Of the 8,650 ft. of dam 850 ft. is Chanoine dam for the navigable pass, 4,000 ft. is Boule dam and the remainder is fixed weir of the types shown by Fig. 5. Altogether there are about 92,000 cu.yd. of concrete in the dam structure, all of comparatively simple structural form. The location of each type of structure is shown by Fig. 4.

The powerhouse structure as it concerns the construction plan is shown in Fig. 4. Its engineering design and equipment will be considered more in detail in a succeeding section. Here it is to be noted only as a concrete and steel structure 534 ft. long and 74 ft. wide calling for 100,000 cu.yd. of earth excavation, 35,000 cu.yd. of rock excavation, 65,000 cu.yd. of concrete, about 1,000 tons of reinforcing steel, and 1,200 tons of structural steel.

In addition it requires to be noted here that the dam is a work for navigation owned and controlled by the United States and the power plant is a private enterprise owned and controlled by the Byllesby Engineering & Management Corporation through its subsidiary the Louisville Hydro-Electric Co. In the 1925 agreement previously noted, the Louisville Hydro-Electric Co. was to build and operate the power plant and the U. S. Engineers (War Department) were to build and operate the dam. As the dam for the combined projects was somewhat longer and more expensive than for navigation only, the power company was to pay an annual rental based on the difference in cost. The agreement was reached so late in the season of 1925 that time would not permit contracting the work and starting that year. The government therefore started the first stage cofferdam construction by day labor, and advertised for bids on the dam. The power company had elected to build the power plant by its own forces. In order to protect the work on the powerhouse as to stream control, securing a tight dam and completing the dam contemporaneously with the powerhouse, the Byllesby Corporation put in a bid for the dam construction which secured it the contract. Later a supplemental contract was entered into for the first stage cofferdam. These dam contracts included the concrete and foundation work only. The government is

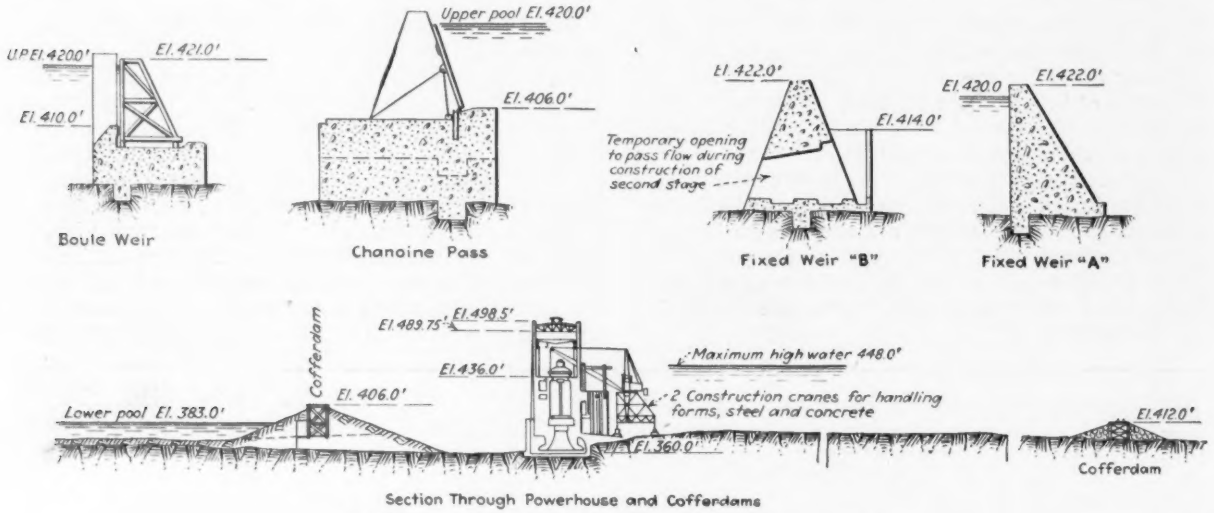


FIG. 5—TYPES OF DAM AND COFFERDAM STRUCTURE

putting in the movable dam. The contract operations amounted to about $2,250,000.

By the arrangement outlined, the construction of dam and powerhouse was placed under one management. It is as one operation, therefore, that the work was planned and will be considered here. The general plan of this operation is shown by Fig. 4.

Cofferdam Construction—Briefly, the plan was to build the powerhouse coffer and the coffer *ABC*, Fig. 4, for the Indiana end of the dam, beginning the work in 1925 and doing as much as possible that season. During the flood season, operations of installing plant and construction of buildings, developing access and other preparatory work were to proceed. With low water of 1926, the first cofferdams were to be completed and the structures within them advanced as far as possible—the dam virtually completed, it was hoped, and the powerhouse structure carried above high water. With the completion of the concrete work in the Indiana end of the dam within the cofferdam *ABC*, this cofferdam was to be removed and cofferdam *DBE* constructed. This provided for the construction of the long stretch of dam from *B* to the powerhouse cofferdam and was to be 1927 work. So much for the plan in general.

With a possible six weeks to two months of low water season remaining in 1925, construction of the upstream dam of the powerhouse coffer was set for fall operation. The downstream dam work was put off until spring (1) because it could not have been completed in time for any fall construction inside and (2) because if completed in the fall the winter floods would fill behind it with silt and add to the power house excavation work. The powerhouse coffer, it is noted, Fig. 4, has an area considerably greater than is necessary merely for the powerhouse. First, the conformation of the river bed between the head of Rock Island and the shore was particularly favorable for cofferdam location and, second, this location made it possible to use the one inclosure to build the bear traps and some 1,200 ft. of fixed weir, besides the powerhouse. The cofferdam structure both up and downstream, Fig. 5, is the Ohio River box-type, with earth fill and stone fill on both sides. The dam upstream is 16 ft. high on rock and that downstream is 28 ft. high on gravel, and has a 30-ft. steel sheetpile cutoff wall to rock. A general view of the completed coffer is given by Fig. 6. The upstream dam was completed in 1925.

FIG. 6—AIRPLANE VIEW OF POWERHOUSE COFFERDAM AND CONSTRUCTION PLANT

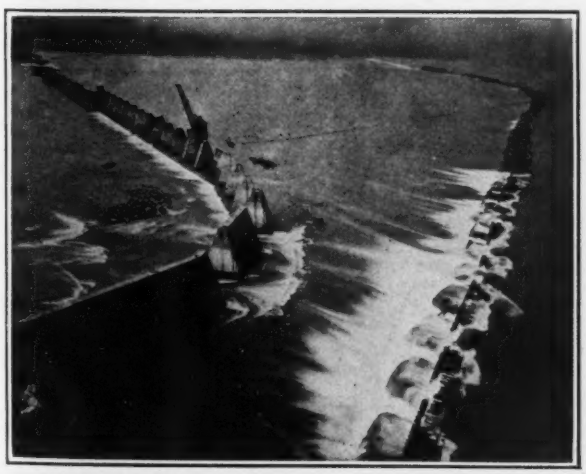


FIG. 7—COFFERDAM AND DAM STRUCTURE IN AN 80,000-SEC.-FT. FLOOD

As was the powerhouse cofferdam, cofferdam *ABC* was begun in 1925, but the river prevented much work. The hydrograph, Fig. 3, shows the working season for 1926. The upstream dam *AB* is about 3,000 ft. long and is a rock-filled crib structure designed, at El. 410, to hold back a flood of 80,000 sec.-ft. Ordinarily, this would provide for a working season of five months. During 1926, Fig. 3, there were 90 working days when work could be carried on, and this with a number of interruptions. About 2,200 ft. of cofferdam were built and some 1,900 ft. of dam completed. Fig. 7 shows the crib dam with an 80,000-sec.-ft. flood, which does not quite top the cofferdam. Fig. 8 is a construction view inside the dam.

The cofferdam work of 1927 comprises the crib dam *BD* and the box dam *BE*, both to be built after dams *ABC* are removed. Dam *BD* will be at El. 414 and will hold back a 150,000-sec.-ft. flood. With a normal river condition, this second stage cofferdam will be completed in 1927 as also will the concrete work of the dam within. In all the cofferdam work only the short working season of 1926 has imposed any handicaps not anticipated.

General Access and Construction—Referring to Fig. 4, it will be seen that on the south shore there were the Kentucky & Indiana Terminal R.R. and the Louisville and Portland canal. On the north shore there were the Pennsylvania R.R. lines available for connections. On the south side there were also the streets accessible to Louisville by the highway bridge at the locks and also by the 18th St. bridge. All access to the construction had to be from or through these shore thoroughfares, as the work proper was in the rapids not navigable except at flood when, as has been developed, no construction in the river bed was practicable. The shore thoroughfares had to be extended into the construction areas.

From the street along the north bank of the canal a construction road was built into the construction plant site adjacent to the powerhouse. The highway bridge at the locks was rebuilt for railway loading and from the Kentucky & Indiana Terminal R.R. a construction railway was carried into the plant site and thence in two loops into the powerhouse cofferdam. With the work undertaken in cofferdam *DBE* a line will take off from one of the powerhouse cofferdam loops and another from the plant site tracks to join in a line parallel to the dam structure as far as cofferdam *ABC* where it connects up with the north shore system. This takes off as a spur line from the Pennsylvania R.R. to the concrete mixing plant and thence in a line along the upstream cofferdam, another along the downstream cofferdam, and a third down into the coffer and parallel to the permanent dam. All of these lines are indicated on Fig. 4. Finally there was the canal which was utilized as described later on.

The railway line though shown complete in Fig. 4, was, it will be understood, constructed in installments as the progress of work called for it. It was the construction agency for virtually all the cofferdam work—except the downstream powerhouse cofferdam which was built by floating plant—and also for the dam construction, Fig. 10, which it paralleled from end to end. Much filling was done from the railway. In general the locomotive cranes handled forms, 15x22-ft. panels, and placed concrete as brought in by railway and took care of excavated material. The first section of dam, 1,200 ft., in the powerhouse cofferdam was built from the powerhouse mixing plant. Simultaneously the second section from the Indiana shore, 2,300 ft., was built from a concreting plant, two 1-cu.yd. mixers, on the Indiana shore. This was 1926 work. With the bulk of the powerhouse concreting done in 1926, the third and long section, 5,000 ft., is being built from the powerhouse concreting plant. It calls for 45,000 cu.yd. of concrete. Except some 20,000 cu.yd., the concrete for powerhouse and

FIG. 8—INSIDE OF INDIANA SHORE COFFERDAM

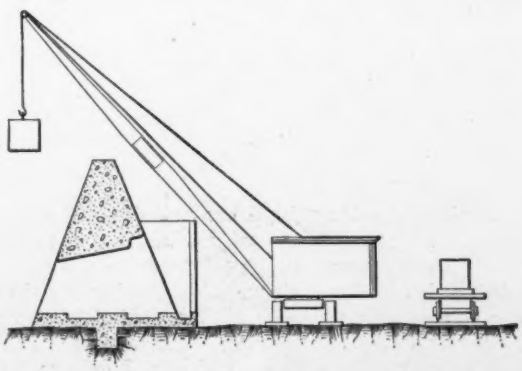


FIG. 9—METHOD OF CONCRETING DAM STRUCTURE

dam, say, 130,000 cu.yd., had to be produced from one concreting plant, which calls for special description.

In general, the powerhouse construction was carried on with two electric-driven 10-ton cranes with 100-ft. booms as shown by Fig. 11. These cranes handled all excavation, forms and steel and placed some 60,000 cu.yd. of concrete in 1926. They worked three 8-hr. shifts a day. Fig. 11 shows work in progress. Much of the speed made in concreting was due to the preparation in advance. The forms were all carefully laid out and built on shore during the winter, and all work planned so the brief season of low water would count high in structure placed.

Materials Handling and Concrete Plant—A high peak production was the first requirement of the main concreting plant. The next plan problems were: (1) Determining the source and delivery of aggregates and (2) controlling concrete quality. The natural location of the mixing plant was near the main concreting operation which was the powerhouse. Here, too, the river bank offered some advantages for the building of a gravity plant. The possible sources of aggregate supply were: To crush the limestone rock from the excavation or to bring in river sand and gravel by truck, by railway, or by canal. Estimates indicated that river materials delivered by canal would be the most economical. As the canal is about a mile from the mixing plant, supplementary haul by railway was necessary. With half a million barrels of cement to be used, economical mixtures and the exact control of mixtures in the normal concreting procedure were essential. With some 60,000 cu.yd. of concrete scheduled for the working season of 1926, Fig. 3, high peak output capacity was paramount. Briefly, then, the plant for producing concrete was of the nature of a special installation calling for special design. The equipment was furnished by the Blaw-Knox Co., and the main units are indicated by Figs. 12 and 13.

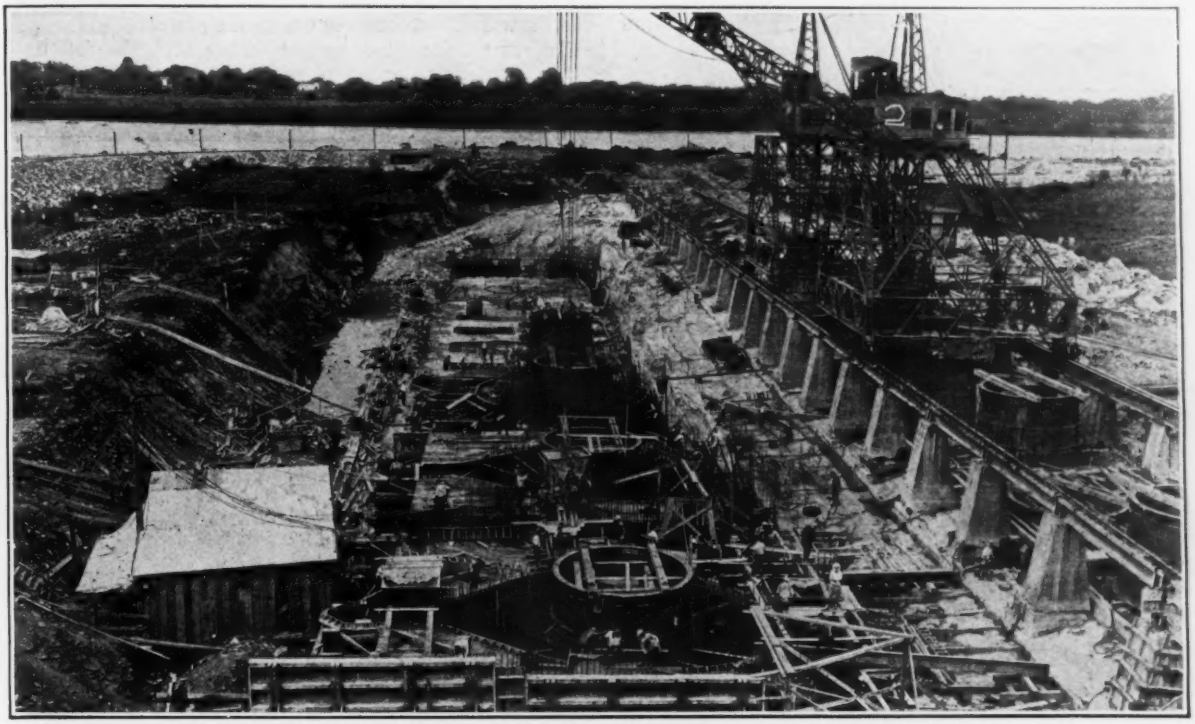


FIG. 10—CONCRETING POWERHOUSE TURBINE EMPLACEMENTS

FIG. 11—CRANE FOR POWERHOUSE EXCAVATION AND CONCRETING

Here it may be interjected that a concrete laboratory was established on the job in September, 1925, thus allowing nearly a year for preliminary work on concrete mix. The engineers specified only the strength and left it to the laboratory to secure this strength with the least expenditure in materials and labor. The man in charge of the laboratory directed the mixing and placing of all concrete. The concrete work in the powerhouse was very complicated and heavily reinforced, requiring a slump of about 8 in. With this slump a 2,500-lb. concrete required 5.33 bags of cement per yard, and 3,000-lb. concrete required 5.93 bags. The average of all cylinders for the 2,500-lb. concrete was 2,708 lb., or within 8 per cent of the designed strength, and for the 3,000-lb. concrete the average value was 3,337 lb., or within 11 per cent of the designed strength. Eighty

per cent of all cylinders made broke within 20 per cent of their designed strength. There were a few extreme variations as high as 80 per cent above and 44 per cent below the designed strength.

Turning now to the plant for producing these results, the first consideration was materials handling. For aggregates coming in by canal barge, three 300-ton circular steel bins, Fig. 12, elevated to discharge into 10-cu.yd. dump cars, were installed near the canal bank. A derrick and clamshell unloaded from barges to bins. From the bins the aggregate trains ran about a mile to the mixing plant and from a trestle dumped into twin 165-ton bins each divided into a sand and a gravel compartment.

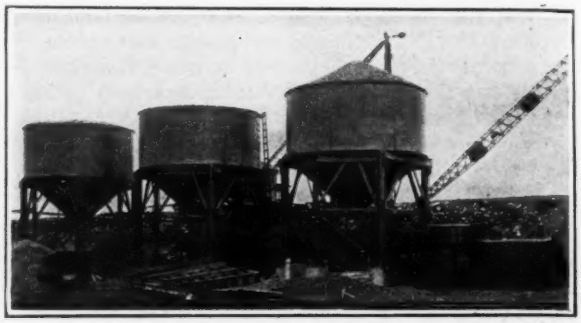


FIG. 12—AGGREGATE STORAGE BINS

The cement, which came in by rail, sacked, was taken by train to a cement house near the mixing plants where it was converted into bulk and carried by a screw conveyor from the cement house to two steel hoppers between the aggregate bins of the mixing plant, Fig. 13. So much for materials handling.

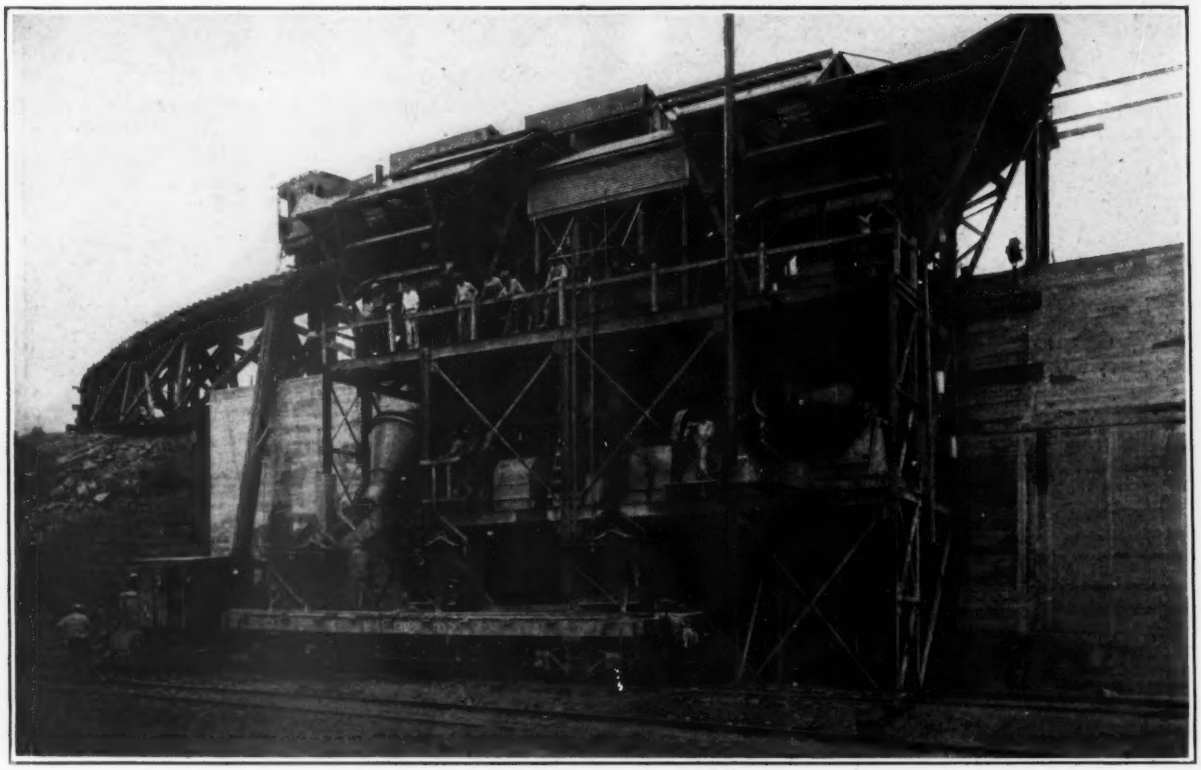


FIG. 13—CONCRETE MIXING PLANT ON LOUISVILLE POWERHOUSE AND DAMS, OHIO RIVER

The mechanical and rigid control of quality was of next consideration. Inundation to control aggregates volume and water was first specified. To get the peak output required, two 2-cu.yd. mixers were necessary. This called for 2-cu.yd. inundators and this size was not then being manufactured. The arrangement, then, was to install two 1-cu.yd. inundators and two stone batchers for each mixer. The aggregate proportioning equipment then consisted of two 165-ton self-cleaning steel bins each equipped with two sand inundators and two stone batchers. The cement proportioning is by weight. Under each cement hopper gate is a batcher car and scale, Fig. 14. With the requisite weight of cement in the car, a latch is tripped and the car rolls back over the mixer and up-ends into the charging hopper. A counterweight returns the car to the scales.

To summarize, then, proportioning is: The fine aggregate is measured by inundation; any additional water for consistency or for the required water cement ratio is tapped from calibrated adjustable excess water tanks; the coarse aggregate is measured by volume; and the cement is proportioned by weight.

Power Plant Design and Equipment—As was the construction procedure, the design of the power plant has been governed largely by the extremely wide fluctuations in water levels. At low stages, the headwater level will be at El. 420, and the tailwater elevation is about 383, giving an operating head of about 37 ft. As the flow increases, the tailwater rises, while the controlled upper pool will remain stationary, with a resulting decrease in head on the plant. When the flow becomes about 350,000 sec.-ft. the tailwater elevation will be 417.5 and the head will be reduced to 2.5 ft. At this flow, the discharge capacity of all the water passages in the dam

will have been reached, and at greater discharges both headwater and tailwater will rise, their difference in levels decreasing slowly until at maximum flow, about 750,000 sec.ft., the head will be entirely extinguished, and the water level both above and below the plant will be approximately at El. 448. The rise in tailwater for a flood similar to the one that occurred in February, 1884, will be about 65 ft. To allow a margin of safety the

during the early months of the year. There will be 45 days in an average year when the head will be less than 10 ft. and no energy whatever generated.

Eight units, each having a capacity of 13,500 hp. at 37-ft. head, will be installed and provision for two additional units is being made at the northern end of the powerhouse. The center-to-center spacing of units is 58 ft., except between units 2 and 3 and between units

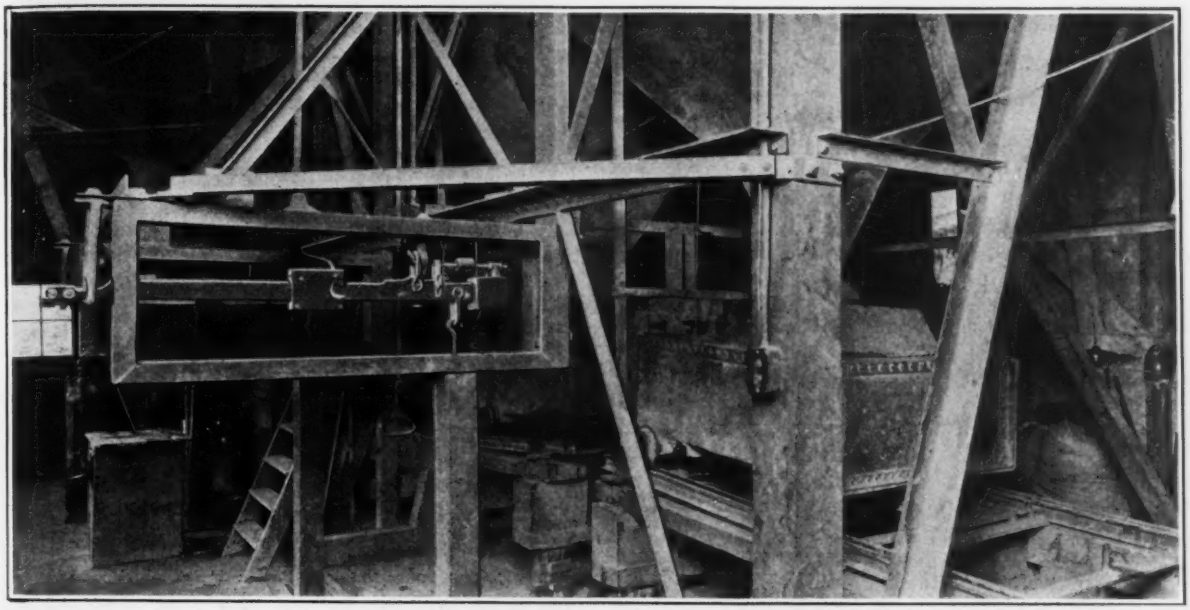


FIG. 14—CEMENT WEIGHING SCALES AND CARS

door and window sills of the powerhouse have been placed at El. 452, Fig. 15, which will allow a rise in tailwater of 69 ft.

The reduction in head due to floods normally occurs

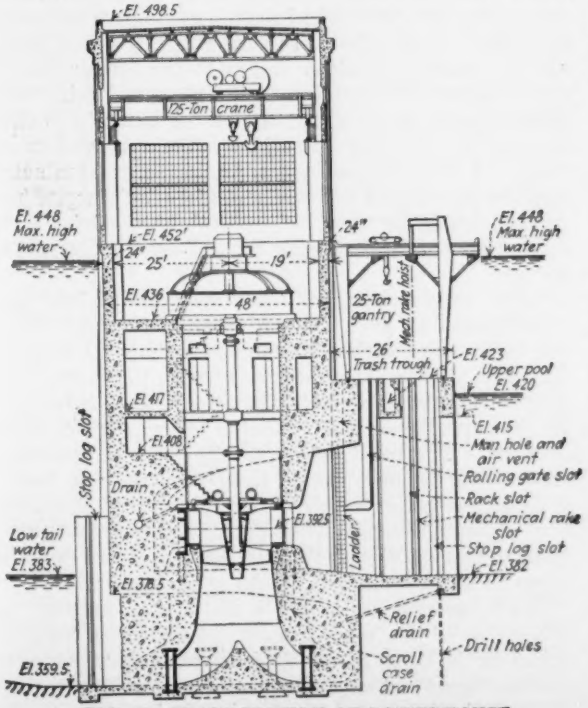


FIG. 15—CROSS-SECTION OF POWERHOUSE

5 and 6, where expansion joints are carried through the structure and the spacing is increased to 64 ft.

The turbines are as large as practice in wheel design will permit, the runners being nearly 15 ft. in diameter. The operating speed will be 100 r.p.m. At 37-ft. head each unit will pass about 4,000 sec.-ft. at full gate, making a total flow through the power plant when fully loaded of 32,000 sec.-ft. The guarantees of power output for operation under reduced head are:

Head in Feet	Brake Horsepower
37	13,500
32	11,250
27	8,900
22	6,600
17	4,500
12	2,600

The advantages of the propeller type of turbine selected for this installation are considered to be: Speed can be maintained through a variation in head from 37 ft. down to about 10 ft. The propeller-type also assists materially in keeping the first cost of the project within economically practicable limits, not only because the higher speed reduces the cost of the electrical equipment, but also because the smaller diameter of the generators reduces the size and cost of the powerhouse.

Direction—The design of the project is under the immediate direction of H. G. Roby, hydraulic engineer, and R. M. Stanley, electrical engineer, and under the supervision of J. W. Link, chief hydraulic engineer, and H. W. Fuller, vice-president in charge of engineering and construction. A. G. Butler is general superintendent of construction. Co-ordinating with them are the U. S. Engineer Corps forces, Col. George R. Spalding, district engineer, and W. H. McAlpine, senior engineer.

Experiments in Crack Regulation in Concrete Roads

Crack Survey of Experimental Pavements Indicates That Proportions of Mix Determine Joint Spacing Required

By Charles E. Turnbull
Associate Construction Engineer, State Highway Department, Raleigh, N. C.

DUE to the frequency of transverse cracks in concrete pavements of both plain and reinforced types the State Highway Commission of North Carolina in 1925 made efforts to localize or regulate the occurrence of these cracks. These efforts took the form of two distinct experiments which were carried out under ordinary working conditions on separate construction projects both of which were located in the coastal region of the state.

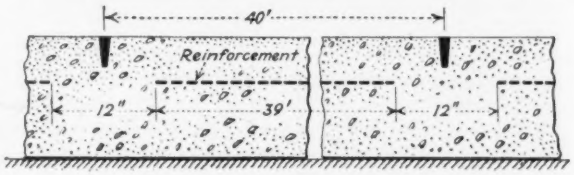
Planes of Weakness—The first experiment consisted of the construction of a 2,000-ft. section having planes of weakness located at intervals of 40 ft. With the exception of this 2,000-ft. section the project was regular in every respect with a reinforced pavement being constructed, having a 7-6-7 cross-section, 16 ft. wide using 1:1½:3 gravel mix. The reinforcement consisted of flat sheets of galvanized steel fabric made with the main members of No. 3 gage spaced on 6-in. centers. The secondary members, also No. 3 gage metal, were spaced on 12-in. centers except for the four outer members which were fabricated from No. 0 gage metal and spaced on 6-in. centers. The widths of the sheets were 1 ft. less than the width of the pavement and they were placed 2½ in. below the finished surface. The subgrade was composed of gumbo clay and loam, poorly drained due to the slow runoff in this flat section of the state.

On the 2,000-ft. section chosen for the experiment, 836.6 lin.ft. were on a 4-deg. curve and 1,163.4 lin.ft. were on a tangent. The transverse cracks were regulated through the construction of planes of weakness on 40-ft. centers, as in the sketch. The reinforcement mats were placed continuously for a distance of 39 ft. at which point was left a section extending the width of the pavement and 12 in. longitudinally without reinforcement. In the center of this section, after the final belting of the surface, was embedded a wooden strip which was cut to the 2 in. crown of the roadway pavement. This strip was of the same width as the pavement and in thickness it was battered from ½ in. on the upper edge to ¼ in. on the lower edge. The strip was merely forced into the concrete until the upper surface was flush with the surface of the concrete and a trowel was used to smooth the surface along the edge of the strip. After the concrete had taken its initial set the strip was removed leaving an indentation or incision 2 in. in depth, ¼ in. wide at the bottom and ½ in. wide at the top, or pavement surface.

The curing was done by the ponding method. After the curing period the pavement was swept off and the incisions examined. In all cases the transverse contraction cracks had occurred in the incisions and they extended through the pavement slab to the subgrade. The cracks were then poured with tar and the pavement opened to traffic. This pavement has gone through winter conditions and to date only one of the 40-ft. slabs has cracked between the planes of weakness. This slab cracked in the approximate center. For a distance of 1,000 ft. on each side of the planes of weakness section the cracks have occurred at very frequent intervals, the average distance between cracks on one end being approximately 22 ft. and on the other end 43 ft. The minimum spacing of the cracks is 5 ft. and the maximum is 89 ft.

Bituminous Joints—The next experiment consisted of the installation of bituminous joints on another project in the same section of the state. The pavement in this case consisted of a plain crushed stone cement concrete pavement constructed with a uniform thickness of 6 in. and a width of 16 ft. using a 1:2:4 mix.

The subgrade on this project was a clay loam having a high moisture content despite the fact that the side ditches were constructed to a depth of approximately 3 ft. below the elevation of the subgrade and at a distance of 25 ft. from the center line of the roadway. The average grade of the pavement was 0.2 per cent with the maximum grade 1.2 per cent. The sections



CONSTRUCTION OF WEAKNESS PLANE IN CONCRETE ROAD SLAB

of the pavement, described below, were built during the months of October and December, 1925, with the air temperatures varying from a minimum at night of 25 deg. to a maximum of 70 deg. during the day.

On the first mile of the experimental section the bituminous joints were placed on 40-ft. centers with the construction details as follows: The expansion joints were placed between two thin steel plates which were of the same crown and section as the pavement, and the plate and the joint were very carefully placed in an upright position at right angles to the center line of the pavement with the top of the plate and joint very slightly lower than the surface of the concrete so that the different finishing operations could be carried on as under the usual circumstances. After 20 or 30 minutes the steel plates were removed and after the concrete had set sufficiently the edges of the slab at the joint were beveled with a ¼-in. edging tool to aid in preventing spalling.

After constructing one mile with the bituminous joints placed on 40-ft. centers, 6,896 lin.ft. of pavement was constructed without bituminous joints, followed by 2.5 miles of pavement constructed with the bituminous joints irregularly spaced with the distance between joints varying from a minimum of 33 ft. to a maximum of 82 ft. The construction details were as described above. On the last section there occurred one buckle and also one transverse crack which occurred at a point 9 ft. from the buckle. There are, however, two other small cracks in the slab. On the section having the joints on 40-ft. centers no cracks or buckles occurred.

The transverse cracks for a distance of 1,500 ft. on either side of the joint sections and also the transverse cracks in the 6,896 ft. of pavement separating the joint sections occur rather infrequently and in the section between the joint section there is one day's run or 754

ft. without a crack. This pavement has also gone through winter conditions.

Conclusion—While none of the experimental sections described above have reached the age to warrant definite conclusions as to the relative value of the planes of weakness or the bituminous joints, the evidence on hand seems to indicate that in localities where climatic and subgrade conditions are as described, planes of weakness or bituminous joints on about 40-ft. centers are needed in reinforced gravel pavement construction where a mix rich in mortar is utilized. For plain slabs using a 1:2:4 mix it appears that joints are not needed as the pavement will crack into relatively long slabs as compared to the shorter slabs which are created by the installation of joints. It may be a good plan, however, on the pavement which contains no transverse joints to make every construction joint an expansion joint from 1 to 2 in. in width.

Composite Steel and Concrete Frame in Fayetteville Bank

Saving Realized by Using Concrete Girders with Trusses as Reinforcement, Bracing and Form Supports

By Walter Atlee
Assistant Engineer, Baltimore County Metropolitan District, Baltimore, Md.

A NOVEL form of steel-frame construction was used in the National Bank of Fayetteville, N. C., built two years ago. A material saving of cost resulted from its use. It has been patented and has been given the trade name of "System S."

The original design for this building was a steel frame with short-span parallel concrete floor-slab construction, slab spans to be about 6 ft. with metal lath ceilings on all floors. All the estimated costs, by contractors, for the completed building were too high. As changes in certain architectural features were desired, it was decided to try to lower the cost of the structural frame by re-design. A new design was therefore made by resorting to a frame of reinforced concrete. On investigation it was found that a material saving could be made by this method, but several elements in this design with bars for reinforcement could not be satisfactorily worked out to conform to certain architectural features of the original design.

The height of the building, in proportion to its width, required that provision should be made for wind pressure. In order to provide a clear space for the requirements of the business of banking on the first floor, it was necessary to offset many columns on plate girders on the second-floor level. Time was a pressing element in the completion of the building, and, as the structural portion would be built during cold weather, after further study to take care of these conditions it was decided to design a frame with steel columns encased in concrete, and concrete beams reinforced by rigid structural frames.

Composite Beams—These composite beams, called for identification S-beams, were designed with truss reinforcement consisting of an angle at the top, one angle at the bottom and a bar in the bottom bent up at the quarter-points and connected to the top angle at each end. The top and bottom angles were connected with narrow vertical plates, spaced to reinforce the concrete properly for shear, and vertical angles at about the quarter-points to act as bracing posts for the bent bar while the steel was bare and the bar acting as a truss rod.

The top and bottom angles were proportioned to take all tension due to wind bending, and account was taken of their value as compression-reinforcement when wind stresses were reversed.

As these beams were to be used to carry temporarily

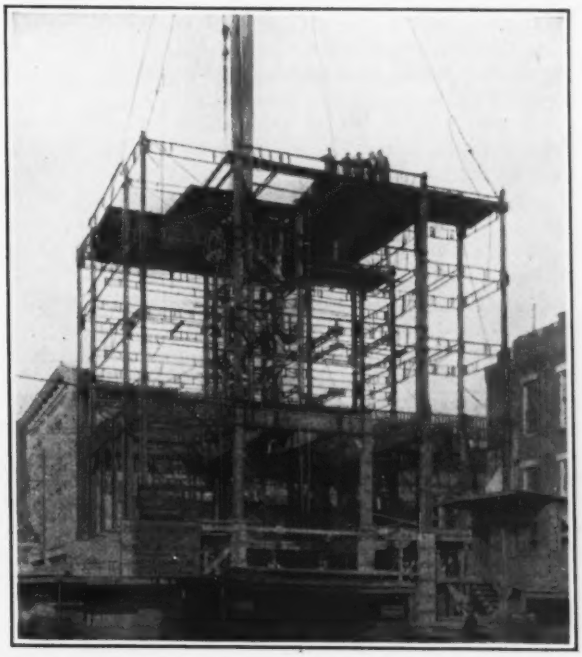


FIG. 1—LOWER PART OF FAYETTEVILLE BANK FRAME
Structural steel reinforcement of concrete girders serves also to space the steel columns, brace the frame against wind, and support the concrete forms.

the loads of forms and concrete, it was necessary to select the top compression angles of sufficient width to carry these loads with no side deflection. After the angles had been selected the bottom bar was proportioned to resist, in combination with the bottom angle, the tension due to the actual dead- and live-loads. Stresses used were in accordance with recommendations of the Joint Committee: 16,000 and 650. Steel columns were designed for 16,000 lb. per sq.in., enclosed with hooping and covered with 4 in. of concrete on all sides.

The finished width of the S-beam when covered with concrete was, in nearly all cases, fixed by the required shear value of the concrete stem at 110 lb. per sq.in. In some cases, however, the computed width became too great and in these beams steel web-plates were introduced at the ends, these plates running from the end toward the center to a point where the limited width of the concrete stem would develop the shear. Girders used for wind braces were rigidly fastened to the columns; deep gusset plates were used to make these connections and at the same time increase the resistance of the column in bending.

It was found possible to design most of the beams with about one-half the steel in the top chord that would be required in the top chord of a similarly de-

signed plate girder or the top flange of a steel beam of equal capacity, the concrete slab developing the balance of the compression required. The top chord of the wall girders was higher than the floor and these girders were figured as rectangular beams reinforced for compression.

Slab Redesigning—In designing the floor slabs it was found economical to change from short-span solid concrete slabs and metal-lath ceiling, as used in the original steel design, to a two-way reinforced hollow tile and concrete floor slab (Schuster arch). In making this long-span arch substitution, a considerable saving in dead-load resulted as compared to the original structural slab design, and in addition it was possible to eliminate the metal-lath ceiling in all typical floors, as the plaster could be applied directly on the tile and concrete slabs.

All intermediate beams used in the original design were eliminated, and the S-beams supporting the slabs were located over partitions, resulting in a flat level ceiling in all offices and increased headroom due to the elimination of the metal lath ceiling. Advantage was taken of this reduced thickness of construction by reducing the height of all typical floors by 6 in., which had the effect of reducing the total height of the building by 4½ ft., a considerable saving.

Saving in Columns and Footings—The decreased beam and slab weight helped to reduce the tonnage of beams and steel columns and made it possible to design more economical column footings. The footings along the walls had to be combined with the interior column footings, so that no part of the foundation would project on adjacent property. The reduced dead-load was an advantage here in reducing the bending moments in these footing girders.

The completed design showed a saving in concrete

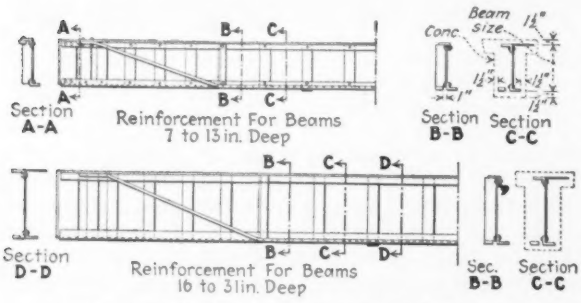


FIG. 2—TYPICAL GIRDER REINFORCEMENT

required for the beams compared to the volume of fireproofing in the structural steel design, due to the fact that the bottom steel of the S-girder required less width of concrete to cover it. The smaller width, however, proved in most cases to be enough to provide for the shearing stresses.

All connections of beams to columns and to other beams were riveted with sufficient rivets to take the full reaction in all cases, no allowance being made for any concrete shear values whatsoever at these connection points.

In actual construction it was found that these light trussed beams formed a rigid, strong frame capable of supporting the erection derrick and all loads incident to the construction, such as scaffolding for steel workers, concrete forms, etc. Although shoring was at first used under the beam forms it was found that this was unnecessary; for a method of centering by which all beam forms were hung from the S-beams by wire hangers made it possible to eliminate shoring. It was necessary, however, to use shores under the long-span floor slabs.

It was found that the fabrication cost of the structural steel in the S-beam design exceeded that of the original steel beam layout, but the increased cost was more than offset by the fact that all connection angles could be fabricated in the beams themselves. So it was possible to run all columns through the shop without fabrication excepting punching for field connections and milling. In the new design there was also less fabrication expense in the windbracing connections than

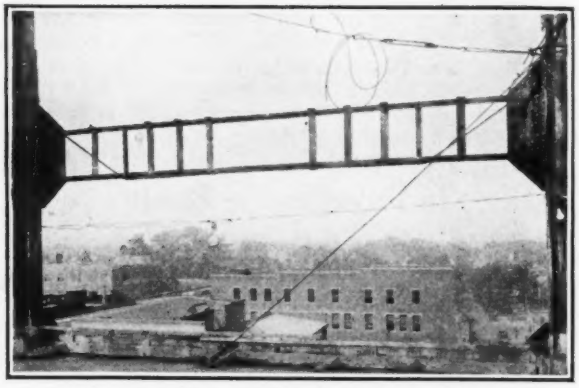


FIG. 3—CLOSE-UP OF GIRDER REINFORCEMENT

in the original design. The steel cost only $2 per ton more than the original standard steel design, and the large saving in tonnage of beams made this item negligible. Throughout the job the weight of steel in all interior S-beams was about half that of equipment structural steel beams; in wall beams the saving was more than one-half on account of the greater depth available.

On submission of the completed design to the contractors for bidding it was found that a net saving amounting to 16 per cent of the cost of the original structural steel and concrete slab design had been secured.

C. C. Hartmann of Greensboro, N. C., was architect for the building. Van Rensselaer P. Saxe, of Baltimore, as consulting engineer, designed the framework.

Maine to Complete Its Topographic Mapping

The Maine legislature, which adjourned April 8, passed an act to secure completion of the topographic mapping in Maine in co-operation with the U. S. Geological Survey and to revise existing United States topographic maps of certain areas, so that a complete and accurate map of the state may be obtained. The sum of $25,000 annually for the first two years and $50,000 annually for seven years thereafter was appropriated on condition that the federal government apportion an equal amount to be expended for the same purpose within the state. Since this work was started in Maine several years ago, 71 of the 192 fifteen-minute quadrangles required to cover the total area of the state have been mapped. The present program calls for the completion of the work in 1936.

Fabricating and Testing Penstocks in Europe

Notes on Shop Practice and Field Tests for High Head Pipe, Particularly Welded and Banded Types—Second Article on European Penstock Practice

By Oren Reed
Assistant Designing Engineer, San Joaquin Light & Power Corporation, Fresno, Calif.

OBSERVATIONS on European practice in the manufacture and in the field testing of high-head penstocks are set forth in the following by way of supplement to an article in European practice in penstock design published in *Engineering News-Record*, May 5, 1927, p. 1180. For high-head service European manufacturers supply welded, banded pipe almost exclusively and for that reason these notes deal chiefly with pipe of that type. The standards and methods described are typical of the plant that specializes in penstock pipe rather than of the large steel mill in which pipe is one of many products.

Shop Practice—After the penstock has been designed the order for the plate is placed on the basis of a definite pipe position for each piece. The length of the plate is usually 6 meters (19 ft. 8¼ in.), while the width is determined by transportation conditions. If the diameter of the plate is such that the circumference is over 7 ft. each pipe section is made from two plates.

Two tension and two bending tests are made on plate from each open-hearth charge. These tests must be satisfactory before the plate is shipped from the steel mills. The ultimate strength of welding steel is expected to be 48,000 to 57,000 lb. per sq.in. and the elastic limit should be 65 per cent of the ultimate strength.

After arriving at the welding shops each plate is sheared to exact dimensions and bent in cold rollers. Longitudinal seams are overlap welded in a welding machine, using a water-gas burner. After being welded the pipe is heated to a red heat in an annealing furnace and then rolled to a true circular section and then painted with a special rust-proofing paint while still hot and before scale has formed. It is not considered possible to make a satisfactory weld with all plate, a steel low in sulphur being specified. As a rule, steel of comparatively low tensile strength and high elongation makes the best welds.

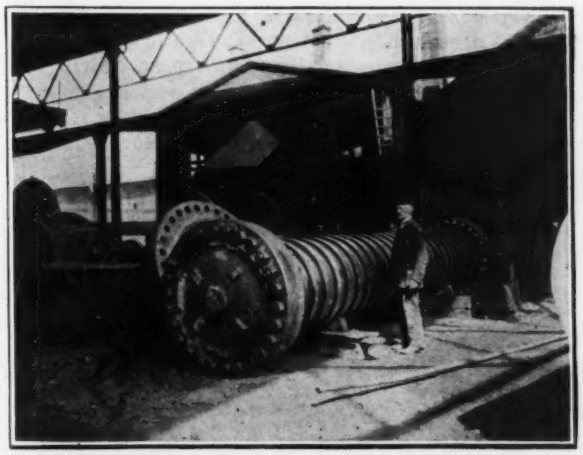


FIG. 1—BANDED PIPE SECTION READY FOR SHOP TEST
Every section is tested at the shop, thus necessitating a test head for every change in design of flange.

After welding, each pipe section is given a hydraulic pressure test. If the pipe is not to be banded it is tested to a pressure 50 to 70 per cent above the static pressure for which it is designed. If it is a core pipe for a banded section, the pressure applied is about 10,500 lb. per sq.in. in the full metal. A plain pipe is not subjected to test pressures above 18,500 lb. per sq.in.

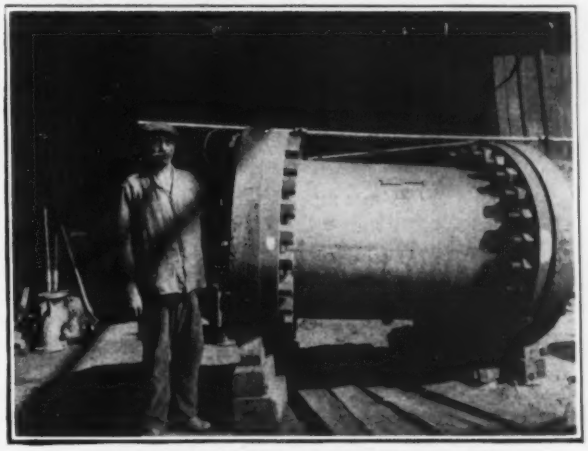


FIG. 2—CAST-STEEL BEND UNDER TEST
Note that bending moment in test head necessitates flange thickness greater than in pipe section. Test-head flange 6.25 in. thick.

The duration of each test varies from ten to twenty minutes after the full pressure is applied. This is ample time to inspect the welds and measure elongation. While the pipe is under full pressure it is struck at points about 6 in. apart longitudinally on and near the weld. Before the pressure is applied, the circumference of the pipe is measured near the one-third points and while under full pressure these measurements are again made to detect any increase in this dimension. Upon release of pressure the pipe must regain its original circumference.

Plain lap-welded pipe is used until the calculated plate thickness exceeds 1¼ in. For higher heads a banded or reinforced pipe is used which consists of a core pipe fabricated and tested in the same manner as a plain pipe, over which are shrunk at proper intervals seamless reinforcing rings. Each ring is forged from an open hearth billet and rolled to the required diameter, width and thickness. The ultimate tensile strength of the band steel varies from 75,000 to 84,000 lb. per sq.in., with a minimum elongation of more than 18 per cent in a 200 mm. (7.88 in.) length.

After the core pipe is tested, the specified positions of the bands are marked. Each band is turned out on the inside for a definite position. The machined inside circumference is slightly less than the pipe circumference in order to obtain a tight fit when the band is

shrunk on the core. After being heated in a furnace the bands are placed on the core pipe in rapid succession and allowed to cool. Since the bands on a pipe section are nearly equal in size, shrinkage stresses will be equal. The final pressure test meets the same over-pressure requirements as the plain pipe but the maximum stress in the full metal is kept below 23,000 lb. per sq.in.

A screw flange joint with rubber packing is used at the lower end of the penstock line, and a minimum thickness of about 1 in. is maintained. The flanges are fitted and welded on after the bands are placed. In order to test the bond of threads and of the weld of the flanges, this type of pipe is tested by bolting cast-steel end pieces to the flanges and applying hydraulic pressure. This puts the pipe in longitudinal tension which is not the case when pipe is tested between the heads of a testing machine.

The specials of a pipe line, as bends and expansion joints, are usually of cast steel. If the required plate thickness does not exceed $\frac{7}{8}$ in. and if the angle is less than 25 deg., bends are made from straight pipe sections by making a slightly diagonal circumferential cut, turning the pipe to give the required angle, and then re-welding.

Expansion housings are tested in the pipe-testing machine while bends and other irregular pieces are tested by bolting on heavy end disks. Cast steel is usually tested to twice its static working pressure. The length of each test is not less than 1½ hr.

If a steel casting shows signs of leakage while under pressure, it is rejected. Any defects which are detected

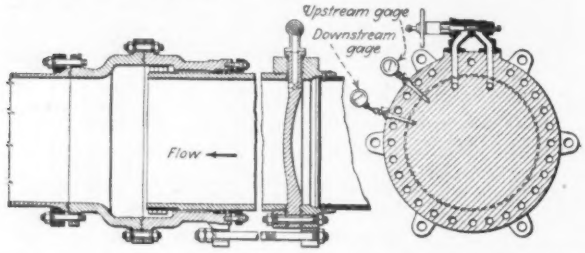


FIG. 3—ARRANGEMENT OF TEST HEAD FOR FIELD USE

during the initial test of the core pipe are marked and repaired by acetylene welding. After being repaired the section of pipe is again tested to the required pressure. No signs of leakage in a banded pipe have been found while under test.

A certain number of pipe sections of various plate thickness and diameters are selected for plate and weld tests. The intent is to make these test pieces sufficient in number to give an average for the whole pipe line. The selections are made before the order for the plate is placed and plate is ordered of sufficient length to allow a ring approximately 6 in. wide to be cut from one end of the test pieces after the pipe is welded. From each of these test rings two pieces for the tension tests are cut from across the two welds and one or more pieces from the full plate. These are then flattened out and machined to obtain a test length of about 10 in. between the shoulders and 200 mm. (7.88 in.) between gage marks. The cross-section, especially for the weld pieces, is left as large as possible to get a representative result. Since the thickness of plate is not reduced, the width of the test piece should be reduced only well within the capacity of the testing machine and never less than the thickness of the plate.

In general the weld strength tends to increase as the plate strength increases. In designing many penstocks it has been assumed that a weld of 90-per cent efficiency would be always obtained. However, this is probably true only for certain ranges. When a thin plate is be-

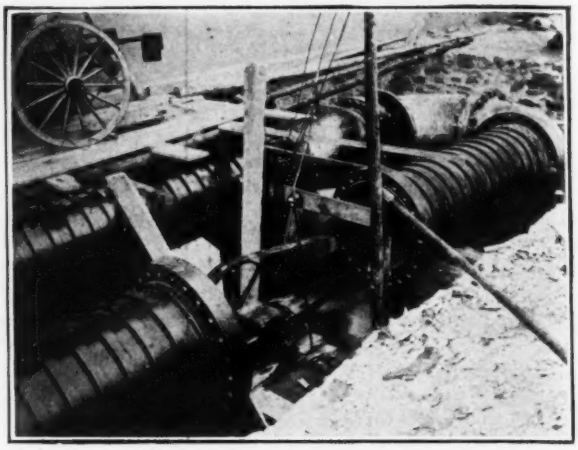


FIG. 4—FIELD TEST UNDER WAY AT COVALOU, ITALY
The farther line is being tested under pressure maintained by pump in foreground. Test head fitted between U-bend and steel casting. Test made by zones, beginning at bottom. Maximum pressure, 150 per cent of static (1,220 lb. per square inch).

ing welded the metal may be burnt and reduced in strength unless the operators are alert and experienced. A plate thicker than 1¼ in. is difficult to heat to an even welding heat entirely through without burning the surface. A plate $\frac{5}{8}$ to 1 in. in thickness will give the most consistent good welds. A $\frac{3}{8}$-in. plate will give a weld of about 95 per cent efficiency while a weld of ¼-in. plate may be as low as 85 per cent efficient.

Field Tests—Although pressure tests of the completed penstock line are seldom made in America, such tests are often made in Europe in addition to the usual shop tests on each section. By the field tests the anchors are given a severe test, which is often of value especially when the footings have poor bearing. In the field the pipe line is divided into sections by means of cast-steel heads in order to approximately reach the test pressure previously used in the factory but not to exceed it in the upper part of each zone.

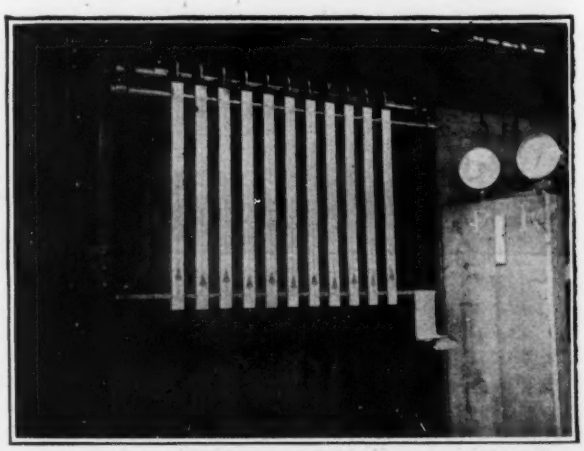


FIG. 5—MEASURING INCREASES IN PIPE CIRCUMFERENCE
Piano wires around the circumference, 6 in. apart record on the boards any stretching in the pipe metal. Pressure gages at right.

Each test head which divides the line into zones is fitted immediately below an anchor between the inner sleeve of an expansion joint and the pipe next above it. When pressure is applied during the test to the section below the head, it is transmitted to the anchor block. It is therefore necessary, when calculating the dimensions of the anchor block, to take this thrust into consideration. The pipes, which are concreted in the anchor, are provided with suitable anchor rings to take the forces acting in the upward direction. The cast-steel heads are provided with bypass pipes and valves for filling and emptying the penstock. The pressure required to be applied during the series of tests is given by an electrically driven pump with a capacity of about 250 g.p.m., connected to the penstock at the lower end.

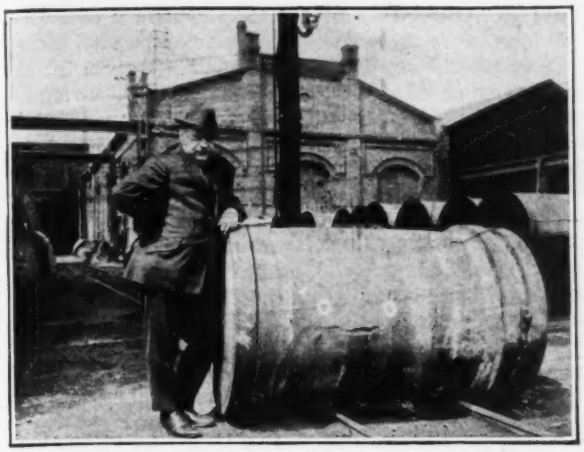


FIG. 6—PLAIN SECTION TESTED TO DESTRUCTION
Note test heads. Bands at ends were shrunk on as in banded sections to prevent rupture around head. The one at right has two pressure connections. The dark stripes are grease placed to allow free movement of wires recording elongation.

After filling the pipe line there are two methods of making the pressure tests: (1) by testing each section separately beginning at the bottom and (2) by testing all of the line at the same time. The latter method is the better one if a sufficient number of intelligent operators are available; an operator must be stationed at each test head.

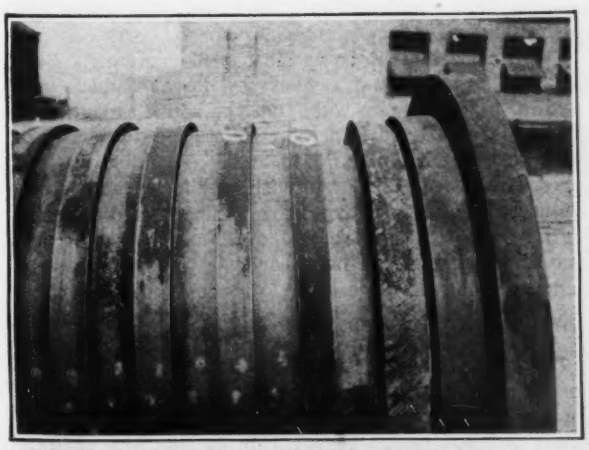


FIG. 7—BANDED PIPE TESTED TO DESTRUCTION
Rupture occurred in weld at point marked near top and did not extend beyond adjacent bands. Note swelling in bands and core, indicating distribution of stresses.

The advantage of the first method is that all operations can receive the personal attention of the superintendent in charge. During the test the pressure is read on each of three manometers, one at the pump and two on the test head. One manometer gives the pressure at the lower end of the zone under test; another gives the pressure below the test head at the upper end of the zone (approximately one-and-a-half times the static pressure at this position); while the third indicates the pressure above the test head. The latter pressure must be at least one-half the static pressure for this point and is applied in order partly to relieve the anchors by a counteracting pressure from above. The duration of each test is on an average about 20 minutes.

By the second method the penstock is filled, with all of the bypass valves open. The water inlets and the bypass valve at the first test head are then closed and the pump started. The pump, as in the first case, is connected to the line at the bottom. When the required pressure is built up on the upstream side of the second test head from the top, the bypass valve at that head is closed. The same method is followed successively down the penstock line. The bypass valves must be opened as necessary to maintain the required pressures above each test flange during the test. If at any time during the test the pressure in any section falls below the pressure in the section above (indicated by the pressure gages) the bypass valve must be opened to equalize the pressure between the sections because the anchor blocks are ordinarily not designed to carry a large unbalanced pressure from above. The superintendent must remain most of the time near the pumping station where he has telephone connections to each test position. After the pipe line is filled, 8 or 10 hr. is sufficient to make the test and thoroughly examine each section of the line.

Destruction Test—In order to fulfill the specification requirements of an American purchaser a series of destruction tests was made on plain lap-welded and banded pipe by the Ferrum Co., Poland, in 1926. Tests were made on six pipe sections, three plain and three banded in thicknesses of $\frac{15}{32}$ in. (24 mm.), $\frac{23}{32}$ in. (18 mm.) and $\frac{9}{16}$ in. (14 mm.). All these sections had an internal diameter of 36 in. In the light of the importance that the banded pipe has attained, this series of destruction tests was placed under the direct supervision of a professor of a noted German technical school.

The manufacturer employed his customary rules for designing the banded pipe in order to obtain the usual proportion of metal in the bands and in the core pipe (approximately 52 per cent in core and 48 per cent in bands) and the proper size and spacing of bands. These tests were made before the manufacture of the banded pipe for this order had started and the subsequent designing of the reinforced pipe was based on the results of the tests.

Stresses in a banded pipe are very complicated and can be only approximately calculated. These stresses are a combination of bending and direct tension. The design of the many important penstocks which employ banded pipe has been based largely on the results of an exhaustive series of tests made about 1910. The original methods of design have been subsequently slightly modified by manufacturing and operating experiences.

The mill tests of the plate made in 1926 indicated a tensile strength of 49,800 lb. per sq.in. with a 25 per cent elongation and a yield point of 35,000 lb. per sq.in. The elastic limit was therefore 70 per cent of the ulti-

mate strength. The tensile strength of the bands was 72,500 lb. per sq.in. with a 21.5 per cent elongation and 45,700 lb. per sq.in. elastic limit (63 per cent of ultimate strength).

For each of the three series of tests (one series for each plate thickness of core pipe) a pipe section about 14 ft. in length was welded. A ring approximately 18 in. in width was cut from the middle of this pipe for weld and plate tests. One end portion, about 6 ft. in length, was tested as a plain pipe, while the other was banded.

For the destruction test on the plain pipe, heads were welded into the ends of the section and nipples were provided for the connections to the pressure piping. When the pipe section was placed in the testing machine only enough compression was applied to hold it in place. Longitudinal stresses were therefore very slight. After the pipe was filled with water, pressure was built up by a 3-stage motor-driven pump. Elongation of the pipe circumference was measured by means of fine piano wire which was securely fastened at one end, passed once around the pipe and then led over a pulley to the instrument board shown in Fig. 5. Constant tension was maintained by a weight and there were six such wires spaced about 8 in. apart along the axis of the test section. Movement was measured by means of a small pointer registering on a millimeter scale. As is shown by the photograph two pressure gages were arranged beside the instrument board for indicating the pressure in the test pipe and at the pump.

The pressure was brought up quickly to the rupture point, the pump being stopped at certain intermediate pressures long enough to record the elongation readings of the circumference. Rupture in each case took place in the weld with a sudden formation of a wide break. Minimum results showed an ultimate tensile strength of 45,000 lb. per sq.in., giving a factor of safety of about 4 on the usual working stresses. Resulting ultimate stress had a wide range above the minimum.

Test procedure for the banded pipe was similar to that for the plain pipe. However, only one end of each section had a welded head, to the other was fitted a heavy expansion joint. While in the testing machine the pipe was supported and no longitudinal stresses were introduced. Elongation of the circumference of six bands and at six points on the core pipe was measured by the arrangement of wires around the pipe.

Rupture took place in the weld in all three banded sections tested. No sign of fracture was noted in a band. The fractures were localized by the bands and kept to small proportion. The ultimate strength was 70,240 lb. per sq.in., giving a factor of safety of about 5.2 on the customary working stress of 13,500 lb. per sq.in. The stress at the elastic limit was 33,000 lb. per sq.in.

The uniformly good test results with banded pipe indicate that this is the logical type for high-head penstocks. In case of a rupture the break is small and little damage would be done before the flow could be shut off. This is in contrast to the typical break in a plain welded pipe which is usually large because the rupture is not localized. The first penstock using banded pipe was installed in 1912 and since that date banded pipe has been used in the high-pressure section of many of the highest-head penstocks in the world. Thus far the writer has heard of no failure of any such penstock.

Ready-Mixed Concrete from Birmingham Plant Finds Increasing Market

RESULTS of the first year of operation of the ready-mixed concrete plant of the Sloss-Sheffield Steel & Iron Co. of Birmingham, Ala., were given in our issue of Feb. 18, 1926, p. 282. The total amount of concrete mixed at the plant during that year, 1925, was about 70,000 cu.yd. Figures for 1926 show a considerable increase in the use of such concrete, the total being close to 100,000 cu.yd. Monthly totals are given in the accompanying table. Climatic conditions in Birmingham are such that the demand for concrete remains fairly constant throughout the year and consequently the plant is now operating close to its capacity most of the time. The best day's run in 1926 was 814 cu.yd.

The plant was described in detail in the article referred to above. It has two mixers, one 1-yd. and one of 2-cu.yd. capacity. Crushed slag used for coarse aggregate is loaded by steam shovel from the slag dump directly behind the plant and is delivered in standard-gage railroad cars to the screens and crusher at the plant. Sand and cement are delivered in the same way.

READY-MIXED CONCRETE SUPPLIED BY PLANT AT BIRMINGHAM DURING 1926

Month	Cubic Yards
January	6,775
February	5,859
March	8,940
April	6,477
May	7,287
June	8,864
July	8,711
August	8,671
September	11,736
October	11,100
November	7,186
December	6,553
Total for 1926	98,159

Two classes of concrete are mixed, one using slag cement, fine Georgia sand and coarse aggregate of slag ranging from ¼ in. to 1¾ in., and the other using portland cement, a coarser sharp sand and a coarse aggregate of slag ranging from ¼ in. to 1¼ in. Special mixes are made if required. The slag-cement mix is used largely by the city of Birmingham for the base of asphalt pavement. It is slow setting and is stated to be not very satisfactory when exposed to weathering but suitable for pavement base and mass foundations.

Inspectors from commercial testing laboratories keep careful check on the mixing and test all cement and concrete mixed at the plant.

The slag is bought from the parent company. Both the slag and portland cement are local products and sand is brought in by rail from the south central part of the state or from Georgia. Prices obtained for the concrete range from $4.75 to $6.75 per cu.yd. for the various qualities of concrete with special rates for large contracts. Hauling charges are 50c. per yard per mile for the first three miles, and 40c. for each additional mile in the immediate neighborhood; special rates are made for long distance hauls. Last year satisfactory results were obtained in hauling a few yards of concrete 37 miles by truck, and a considerable quantity was hauled to Bessemer, 13 miles, without undue segregation. J. E. Donelson, manager of the plant, states that the reason why this concrete can be hauled long distances without undue segregation is that the weights per cubic foot of the slag, cement, and sand are nearly equal, the slag being slightly lighter than the cement.

Designing the Carquinez Cantilever Bridge

Economic Studies Determined Type and Proportions of Structure Comprising Two 1,100-Ft. Spans—Details Include Multiple-Pin Joints and Hydraulic Buffers to Cushion Longitudinal Shocks

By D. B. Steinman,
Robinson & Steinman, Consulting Engineers, New York

CARQUINEZ STRAIT Bridge in California, now approaching completion, is of the cantilever type with two main spans of 1,100 ft. This span-length makes it the second largest cantilever bridge in the United States and the fourth largest in the world. (The Quebec Bridge over the St. Lawrence River has a main span of 1.800 ft., the Forth Bridge in Scotland has two spans of 1,700 ft., and the Queensboro Bridge in New York City has two spans of 1,182 ft. and 984 ft. respectively.) The Carquinez bridge is also notable for its deep pier foundations, 132 ft. below water level, described by George J. Calder in *Engineering News-Record* of March 24, 1927, p. 484. Another feature of interest is the consideration which was given to possible earthquake forces in designing the structure and in providing special protective details.

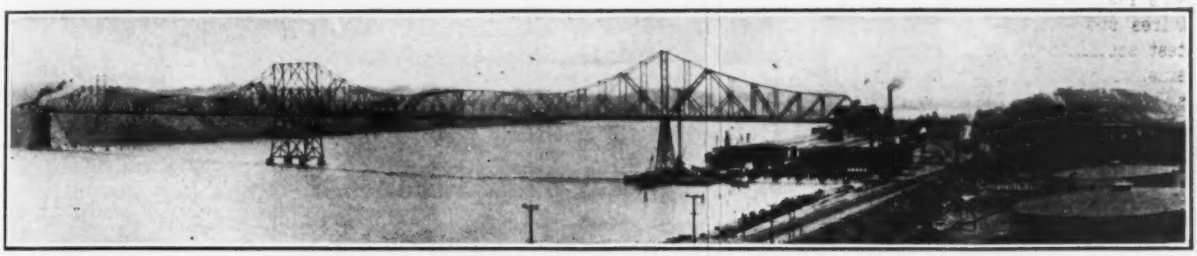


FIG. 1—CARQUINEZ STRAIT BRIDGE—ONE OF WORLD'S LARGEST CANTILEVERS
Replaces old highway ferry on route from San Francisco east and north to Sacramento and Pacific Highway.

Location—The bridge spans the western end of Carquinez Strait, about 25 miles north of San Francisco. The north end is at Morrow Cove near Vallejo in Solano County, the south end near Crockett in Contra Costa County. This crossing is on the established line of travel from the San Francisco Bay region to Sacramento and other points in the northwestern and central part of California. The bridge will supplant the service of the Rodeo-Vallejo Ferry Co., which has hitherto been handling this traffic. The routes of the transcontinental Lincoln Highway, via Sacramento, through the Sierra Nevada Range; the Pacific Highway along the Pacific Coast, and a branch of the Redwood Highway will cross here.

Principal Dimensions—The main bridge has two anchor arms of 500 ft., two cantilever spans of 1,100 ft., and a central tower span of 150 ft., making the total length of the main structure 3,350 ft. (The corresponding length of the Queensboro Bridge is 3,724 ft.) Each 1,100-ft. span consists of two cantilever arms of 333 ft. 4½ in. and a suspended span of 433 ft. 2⅜ in. At the southern end, the bridge has a steel viaduct approach 1,132 ft. long, making the total length of the bridge 4,982-ft. between abutments. This approach viaduct involved some complications of design, as it is on 10-deg. curve, has a grade of 1.6 per cent, and is of skew layout, because of crossing the Southern Pacific R.R. tracks.

Pier 1, the north abutment, rests on sandstone in the north hillside, and piers 9 to 12 of the south approach on shale. The south end of the cantilever structure, pier 5, as well as the three approach piers 6 to 8, rest on timber piles. Pier 4, the main pier of the south cantilever, is founded at El. —51 on concrete piles, and was built in a timber cofferdam. The remaining piers of the main structure, piers 2 and 3, are deep foundations sunk by open dredging to rock, a maximum depth of 132 ft.

Superstructure Studies—The first design studies were for a suspension bridge of 1,600-ft. main span with two 800-ft. side spans. This layout placed the south main pier 400 ft. north of the south pierhead line, and the navigation interests objected to this obstruction of the channel. A 1,950-ft. suspension bridge and a cantilever bridge with two 1,100-ft. main spans were then proposed. Cost estimates showed the double-span cantilever to be $700,000 lower in cost. Both layouts were submitted to the War Department with the request that the cantilever design be approved. This was granted, and the cantilever layout was adopted.

A double-span suspension bridge, with two 1,100-ft. main spans, might have proved more economical than the double-span cantilever design, but the principals preferred to avoid the suspension type on account of difficulties and uncertainties in the anchorage conditions at the site. In comparative studies of other types, four continuous spans of 500, 1,175, 1,175 and 500 ft., did not prove economical, nor as convenient for erection as the cantilever design. A suspension-cantilever design resembling the Florianopolis type of suspension span but designed to function without horizontal anchorage reactions, offered certain erection advantages, but the estimates indicated that it would cost $162,000 more than the conventional cantilever design.

Development of the Design—The preliminary design showed a bridge width of 35 ft. center to center of trusses, to accommodate a three-lane (30-ft.) roadway, without sidewalks. A greater width appeared desirable for transverse stiffness and stability. Calculations showed that the bridge could be widened from 35 to 42 ft. center to center of trusses and two inside

sidewalks added for $137,000, whereas the cost of adding one outside sidewalk on brackets without widening the bridge would be $172,000. The bridge widening was therefore adopted, and the spacing of the pier shafts increased from 75 ft. to 83 ft. It was found also that provision for a possible future single-track electric railway supplanting the central lane of highway loading would add only $210,000, and this provision was authorized.

For the suspended spans, a "curved" top chord was found more economical than a straight top chord by a substantial margin (12 per cent reduction in the trusses and a total saving of $80,000), and was adopted. The economic depth-ratio at mid-span was found to be 0.17; the depth finally adopted was 72 ft. in a span of 433 ft., or a ratio of 0.167. It was calculated that a variation (uplift); above 520 ft., the reactions would always be positive (no reversal); in the range between 470 and 520 ft., reversals may occur under special loading conditions, but positive reactions will predominate.

From the preliminary design layouts, the economic profile for all the spans was obtained by plotting a curve with ordinates equal to the square-root of the maximum calculated bending moment at each panel point, thereby making the truss depth at each point a mean proportional between a uniform depth and a depth of constant strength. This yielded a pleasing and practical top-chord profile, which was retained with little modification. The layout with curved-chord suspended spans, aside from its economic advantage, is justified by considerations of appearance, since it best expresses structural function and economy. In addition to the

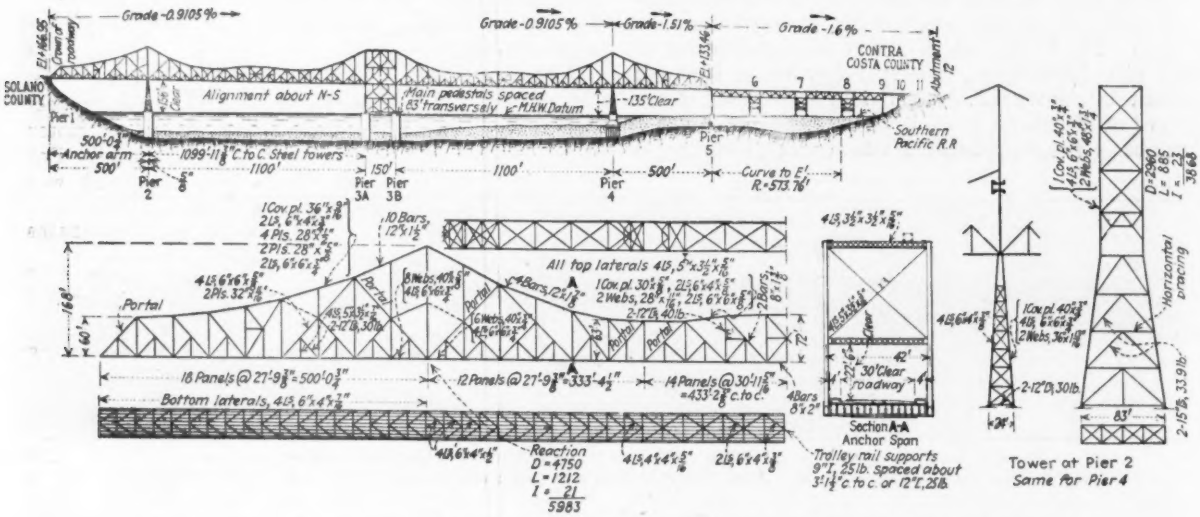


FIG. 2—GENERAL ELEVATION AND TYPICAL FEATURES OF PROPORTIONING OF MEMBERS

of 5 ft. from the economic truss depth would increase the estimated cost by $25,000. The depth at the hips was made 60 ft., for appearance, when it was found that there was practically no difference in cost for a 10-ft. increase from the previously considered hip-depth of 50 ft. Various systems of trussing were studied, including the K-type, but the Pratt trussing was found most economical and was adopted.

In the original layout, the height of the main towers was 150 ft. or 0.136 of the main span. In previous large cantilevers, the tower-height has ranged from 0.13 to 0.20 of the span, with an average ratio of 0.17, but these were mostly railway bridges. Economic studies for the Carquinez design showed that $43,000 could be saved by increasing the tower height from 150 ft. to 175 ft.; following erection studies, the latter value was reduced to 168 ft., yielding a tower-height-ratio of 0.153.

For the suspended spans, the economic length was found to be 500 ft. when erection by the cantilever method was contemplated. Later, when erection by the lifting method was decided upon, this span length was reduced to about 433 ft. in order to reduce the weight to be floated and lifted.

The profile of the crossing practically fixed the length of the anchor arms at 500 ft. each. Calculations showed that the critical length for these anchor arms is 470 ft.; below 430 ft. the end reactions would always be negative reversal in the top-chord profile, the suspended spans are distinguished from the cantilever arms by the change in trussing. The true functioning of the entire structure is thus made clearer to the eye, without the confusion resulting from attempts to disguise the cantilever construction.

As a basis for the initial estimate of cost, a tentative layout had been used in which the truss-panels were made 50 ft. long, with intermediate floorbeams supported by bending in the bottom chords. Comparative studies showed that subdivided trussing, yielding shorter panels, was decidedly more economical. In the final design, the panel lengths are 27 ft. 9⅜ in. in the anchor and cantilever arms, and 30 ft. 11⅛ in. in the suspended spans. In the 150-ft. tower span, a choice between six panels of 25 ft. and four panels of 37½ ft. was decided in favor of the longer panels, following economic comparisons in addition to considerations of stress analysis, erection problems and appearance.

For supporting the electric railway track, four different stringer arrangements were studied. These, in the order of economy found for them, were: one stringer per rail, with rails on cross-beams; one stringer per rail, with rail directly over stringer; two stringers per rail; and three stringers per rail. The total range of resulting cost variation was found to be $179,000, and the cross-beam design was adopted as the most economical.

Economic studies were made to ascertain the extent to which silicon steel could be profitably employed for the truss compression members. For the 1,100-ft. main spans, it was found to be economical to substitute silicon steel for structural (carbon) steel, up to a price differential of 5c. a pound. The quoted differential was only 1¼c. a pound, on which basis the adoption of silicon steel for the truss compression members yielded a saving of $600,000 in the cost of the bridge. In the anchor arms, dead-load is desirable in order to minimize the negative bending moments; consequently in these spans the silicon steel lost most of its economy,

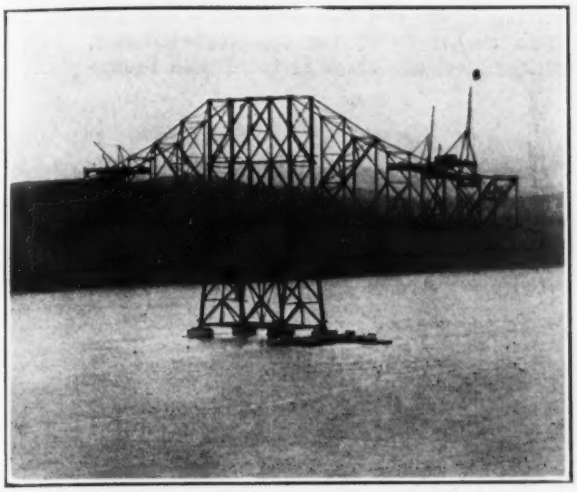


FIG. 3—CENTRAL TOWER AND CANTILEVER ARMS
Tower, 83x150 ft. at base, supported on 34-ft. concrete shafts resting on 40-ft. square shafts dredged down to rock at maximum depth 132 ft. Truss depth over tower 168 ft.; trusses spaced 42 ft.

and the extent of its utilization was left to the option of the steel contractors.

Cross-Sections—The trusses are spaced 42 ft. center to center, providing space for a roadway 30 ft. wide between curbs, and two sidewalks 4 ft. wide. On the curved section of the approach, the roadway is increased to a clear width of 32 ft. and is superelevated 7½ in. The floor is a reinforced-concrete slab 7 in. thick, with 3-in. crown and 9-in. curbs. The sidewalk is a 4-in. slab sloping 1 in. toward the curb for drainage. The middle strip of the roadway slab, 5 ft. 9 in. wide, covering proposed future track space, is separated from the adjoining slab by longitudinal joints.

Transverse expansion joints across the full width of the bridge are provided in the concrete slab over alternate floorbeams. These expansion joints are of "Carey Elastite" construction, ¾ in. wide in the roadway slab and ½ in. wide in the sidewalk slab. Over the other floorbeams (at the sub-panel points) the concrete slab and its reinforcing are made continuous. Special grid expansion joints, shown in Fig. 4, are provided at the expansion joints of the structure.

Design Loads—The floor system was designed for a loading of 3 lines of 20-ton trucks, or 2 lines of 20-ton trucks occupying areas of 10x32 ft., with an electric train occupying the middle lane between them, followed and preceded by a uniform loading of 600 lb. per lin.ft. The electric railway loading was assumed to consist of a train of 96,000-lb. cars 60 ft. long, with wheel concentrations of 12,000 lb., displacing one line of motor trucks with its following uniform load, for a maximum length of 500 ft. The sidewalk loading was assumed at 50 lb. per sq.ft.

As a correction for the probability of concurrence of maximum concentrated loading on three traffic lanes, the following factors were applied to stresses calculated from combinations of loading (in accordance with the A.R.E.A. Specifications for Steel Highway Bridges): For stringers 100 per cent, for floorbeams and hangers 90 per cent, for viaduct trusses, girders and columns 80 per cent.

For trusses and pier reactions, a uniform loading of 2,600 lb. per lin.ft. was assumed for a length of 500 ft., followed and preceded by a uniform load of 1,800 lb. per lin.ft. of indefinite length. This loading represents a highway loading of 60 lb. per sq.ft. covering the entire width of the 30-ft. roadway except where it is displaced by an electric train weighing 1,600 lb. per lin.ft., 500 ft. long, with 500 lb. per lin.ft. of highway loading on each side. This loading was assumed to cover such portions of the span lengths as to produce maximum values of the respective stresses and reactions.

In proportioning floor members and hangers, impact of 30 per cent was added to stresses from the motor trucks, and 20 per cent to stresses from trains. For the trusses and girders, the impact increment was

$$\frac{100}{nL + 300}$$

for motor trucks, half as much for trains and 70 per cent for combined loading; where n is number of lines of traffic and L is length (in feet) of live-load producing the calculated stress.

The lateral wind load was calculated as a moving load at 30 lb. per sq.ft. on 1½ times the vertical projection of the structure on a plane parallel with its axis. The longitudinal wind load was calculated at the same intensity on the unshielded surface exposed to such wind including half the aggregate vertical projectios of all web members and swaybracing on a plane normal to the axis of the structure.

Materials and Stresses—Silicon steel (80,000-95,000 ultimate, 45,000 minimum yield-point) was adopted for the main material of the towers, and for compression members and built tension members in the trusses of the suspended spans, cantilever arms, and anchor arms. It was allowed 40 per cent higher working unit stress than structural (carbon) steel. Silicon steel was not available nor recommended for rolled shapes, and is generally limited to plates or angles not exceeding ¾ in. in thickness.

For the principal tension members in the main trusses (and for some tension members in the viaduct trusses), heat-treated carbon steel eyebars of the medium grade were adopted. This grade is specified to have a minimum elastic limit of 50,000, a minimum ultimate resistance of 80,000, and a minimum elongation of 8 per cent in 18 ft. It had been used since 1915 in about six bridges prior to the Carquinez bridge, and had a record of 61 full-size tests with no failures; these tests showed an average elastic limit of 57,900, an average ultimate resistance of 86,700, and an average elongation of 10.3 per cent in 18 ft.

For purposes of estimating and for use in economic studies, the following unit prices (per pound erected) were applied on the basis of information furnished by the steel companies: Structural steel, 9½c.; silicon steel, 10¾c.; heat-treated eyebars, 11c.; viaduct structural steel, 11c.

The privilege of inspecting the heat-treated eyebars in the process of mannufacture had to be waived by the purchaser, the manufacturers maintaining their policy of secrecy. Brinell hardness readings taken on the bars, before and after heat-treatment, afforded some indication of uniformity. Chemical analyses were also secured. The results of the full-size tests exceeded the specified requirements.

The basic unit stress for the combination of dead-load, live-load and impact in structural steel was 16,000 lb. per sq.in. in tension and $15{,}000 - 50\,\frac{l}{r}$ (but not to exceed 12,500 lb. per sq.in.) in compression. For silicon steel these stresses were increased 40 per cent, and for the heat-treated eyebars 50 per cent.

structure is made at the shore end of each anchor arm (pier 1 and tower 5), and at the shore end of each suspended span. For simplicity of details and for greater security against longitudinal forces (including possible earthquake effects), each suspended span is fixed to the tower cantilever arm, the entire 11-in. expansion of the 1,100-ft. span being provided for at the shore end of the suspended span.

At the north abutment (pier 1) a wind-bracing anchorage is provided to take care of the lateral wind-load reaction while permitting the longitudinal expansion movement. The wind reaction is taken from the center line of the end floorbeam and is carried down a built-up anchorage to the concrete abutment. This structural steel anchorage is faced with bronze plates

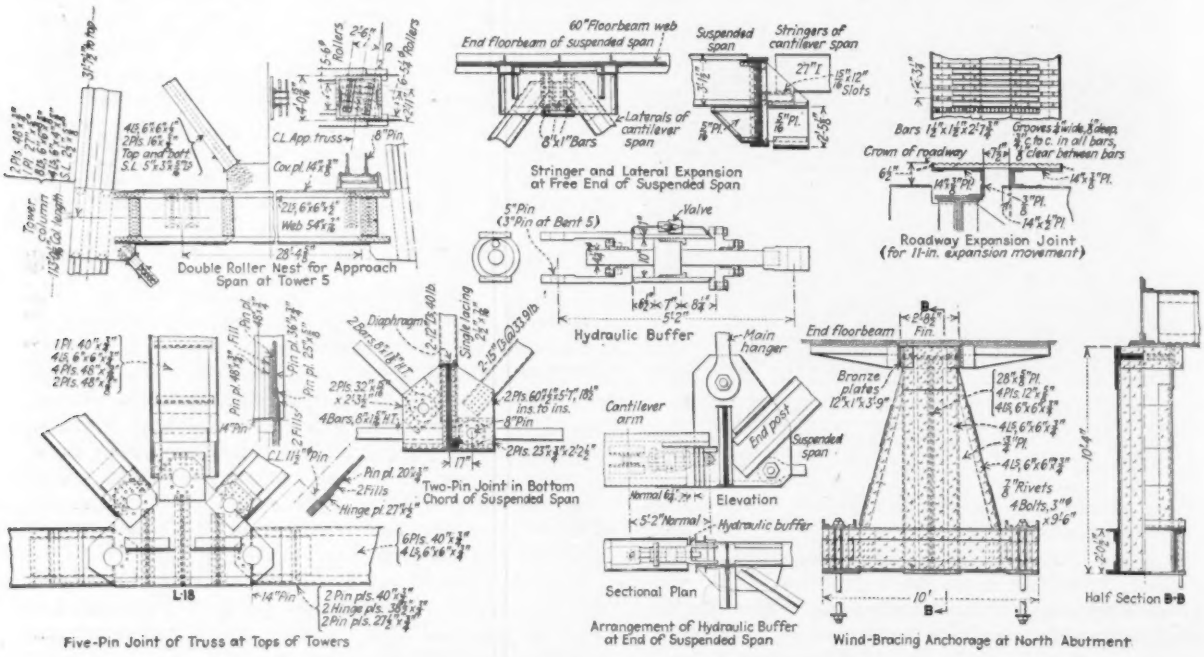

Double Roller Nest for Approach Span at Tower 5
Stringer and Lateral Expansion at Free End of Suspended Span
Roadway Expansion Joint (for 11-in. expansion movement)
Hydraulic Buffer
Two-Pin Joint in Bottom Chord of Suspended Span
Elevation
Sectional Plan
Arrangement of Hydraulic Buffer at End of Suspended Span
Wind-Bracing Anchorage at North Abutment
Half Section B-B
Five-Pin Joint of Truss at Tops of Towers

FIG. 4—SOME IMPORTANT DETAILS OF CARQUINEZ STRAIT BRIDGE

The main sections of members subject to reversals of stress were proportioned to resist each stress without increase on account of reversal; but the connections of such members were proportioned to resist either stress augmented by 50 per cent of the other.

Special Design Features—The lengths of all members of the main bridge structure were carefully computed and fabricated, making allowance for the elastic changes of lengths from dead-load, so as to give the desired geometrical form of the trusses when the full dead-load is on the structure. In order to eliminate from the finished structure, as far as possible, all secondary stresses due to dead-load, it was prescribed that all riveted connections should be laid out to angles corresponding to the final geometrical configuration of the trusses, and not to the angles corresponding to the cambered lengths.

In the main bridge structure, the truss verticals were made perpendicular to the bottom chord, not vertical, in order to permit the same shop templets to be used for all similar parts of the bridge. The resulting inclination of only 1 per cent is hardly noticeable.

Provision for longitudinal expansion of the main

for sliding bearing against brackets secured on the underside of the floorbeam.

At the bottom-chord panel points at towers 2 and 4, multiple-pin details were adopted to minimize the secondary stresses and to facilitate erection. Hinge-plate details prevent possible separation under severe earthquake effect; the rivets for closing these hinges were not driven until full dead-load stress was acting.

The decision to erect the suspended spans by the lifting method made it possible to use eyebars for the bottom chords in those spans. A novel connection detail was adopted for the bottom chord panel points in those spans: Two independent pin connections are provided, one for the eyebar diagonal, the other for the bottom chord eyebars. This design yields simplicity and economy of framing with no eyebar heads interfering with the floorbeam connection.

The end of the south anchor arm is pin-connected to the top of tower 5, which tower rocks on its base pin with the expansion of this anchor arm. The approach span truss bearing on this tower has a double roller-nest expansion, necessitated by the angle of curve of the approach; the lower roller nest is set in the direction

of the main bridge structure, and on it is superimposed the second roller nest oriented in the direction of the approach truss span; the angle between the two roller expansions is approximately 9 deg, 28 min.

Provisions for Earthquake Resistance—As a protection against possible earthquake effects, the following features were incorporated in the design of the structure in order to limit and check undesired longitudinal movements.

Structural stops are provided at the ends of the main structure (pier 1 and tower 5) to limit the longitudinal movement to the necessary temperature expansion. At tower 5, which is a rocker tower, the structural stops

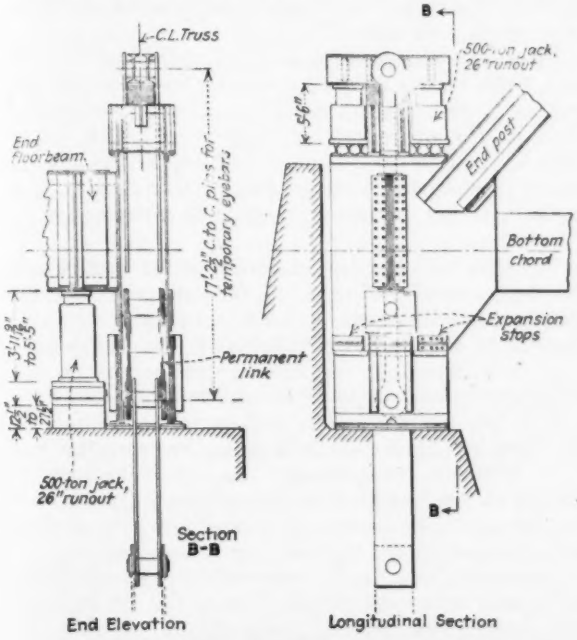


FIG. 5—TEMPORARY UPLIFT ANCHORAGE AT NORTH ABUTMENT

Anchor arm built by cantilevering over steel rocker bent at mid-length. Uplift anchorage controlled by jacks to permit making connection with main tower.

are provided by extending the top chords of the approach-span truss, these otherwise unnecessary top chord members being proportioned to develop the compression strength of the top chord members from which they extend.

Hydraulic buffers are provided at the expansion joints between the suspended spans and the shore cantilever arms, also at tower 5 between main structure and viaduct, in order to check longitudinal vibration or any sudden longitudinal movement. The check valves in these hydraulic buffers are proportioned to permit slow passage of the fluid for ordinary thermal expansion movement, but to close against more rapid flow of the liquid thereby preventing sudden relative movement. Six of these hydraulic buffers are provided; four of them are secured in the bottom chords of the trusses at the expansion joints, and two are secured between tower 5 and the extended top-chords of the approach span. Their valves will close and arrest the motion of the main piston whenever force is applied with a velocity exceeding 0.4 in. per second. This is 1/28 of the velocity recorded in the 1906 earthquake near the fault line.

The horizontal earthquake force assumed in the investigation of the structure and in the proportioning of the buffer details, 320,000 lb., corresponds to an assumed maximum acceleration of 15 in. per sec. per sec.

Raising of the Suspended Spans—The two 433-ft. suspended spans were designed to be placed by the lifting method of erection. Saving in time of completion was the governing consideration. While the cantilever arms were being built out to receive them, the two suspended spans were erected, in succession, upon falsework on a temporary dock nearby, and were then floated out and lifted into position. The operation of lifting was described by C. G. Goodrich in *Engineering News-Record* of April 28, 1927, p. 686.

For ease and speed in driving the final connecting pins in the hangers of the suspended spans, the holes were slotted ½ in. in the eyebars and 2 in. in the gusset plates. The first boring, furnishing the bearing semicircle, was made ½ in. larger than the diameter of the pin, and the second boring was made ⅝ in. larger than the pin diameter.

Quantities—The total tonnage of steel in the Carquinez bridge (excluding concrete reinforcement) is

	Structural Steel, Tons	Silicon Steel, Tons	Heat-Treated Eyebars, Tons	Eyebars Untreated Tons	Total Tons
Approach viaduct	1,612	.....	34	26	1,672
3 Main towers	645	1,096	.....	..	1,741
2 Anchor arms and 4 cantilever arms	3,503	3,478	1,184	11	8,176
2 Suspended spans	825	423	190	52	1,490
					11,407
Hand railings	215	.....	.....	..	215
Total					13,294
Erection material	104	5	.....	5	114

Organization—The Carquinez Strait bridge is the project of the American Toll Bridge Co. It was started and carried toward completion under the presidency of the late Aven J. Hanford. On his death in 1926, Oscar H. Klatt succeeded to the presidency and George J. Calder, resident engineer, was made vice-president and general manager of the company.

The engineering of the project has been under the direction of Charles Derleth, Jr., as chief engineer. William H. Burr was retained as consulting engineer and the writer as designing engineer.

The principal substructure contract was executed by the Missouri Valley Bridge and Iron Co., following preliminary substructure work by Duncanson & Harrelson of San Francisco. The superstructure contract was executed by the U. S. Steel Products Co. under the direction of C. G. E. Larsson, assistant chief engineer of the American Bridge Co., and C. F. Goodrich, assistant engineer of that company.

States Adopt Model Traffic Control Law

Summarizing the activities of state legislatures in connection with the Uniform Motor Vehicle Code, Secretary Hoover announced that the uniform law suggested by the Conference on Street and Highway Safety had been adopted by Idaho, North Carolina, North Dakota and Oregon; that Alabama, Arizona, Mississippi, Michigan, Utah and Texas had adopted parts of the code, while Connecticut, Delaware, Massachusetts and New Hampshire had amended their motor vehicle laws on the basis of suggestions formulated in the course of deliberations of the two national safety conferences held in Washington.

American Business Goes to Geneva

Special Reports from the International Economic Conference, by E. J. MEHREN, Vice-President, McGraw-Hill Publishing Co.

Aboard S. S. George Washington, April 27, 1927

HISTORY in the making often has little appeal to us. Its significance has not yet become apparent. This thought has occurred to me again and again as I have watched and visited with the American delegates to the International Economic Conference.

The thought has been made more impressive by an autographed order of Benjamin Franklin's hanging in the library of the ship. Every schoolboy knows of the significance of Franklin's mission to the French court during the Revolution. Yet we have been little impressed at the time by the missions that have gone abroad in recent years to aid in one way or another in the stupendous task of restoring health to sorely exhausted Europe. Sometimes the fine fruits—as in the case of the Dawes Commission—were apparent before the close of the mission's task, so that the return of the members was met with loud acclaim.

On this ship is another mission whose going may in the future be looked on as Franklin's and other historical missions now are. To contribute of American experience to the solution of the world's economic problems, and particularly of those of Europe—such is the task and privilege of the gifted economic delegation aboard this ship.

Competence of Delegation—Of the competence of official delegates, their distinguished records are sufficient evidence. Without exception they are students of international affairs and three of them are veterans in international conference, accustomed to the atmosphere of such gatherings and prepared from the opening signal to work efficiently. Henry M. Robinson, chairman of the delegation, is best known to the general public as one of the three American members of the Dawes commission, the other two being General Dawes and Owen D. Young. But Mr. Robinson had a record in international conference even before his service on that distinguished body. From January to June, 1919, he was one of the five American members of the Supreme Economic Council, handling all manner of economic problems inherited from the war and advising with the President on peace treaty matters. Moreover, he and Samuel Gompers were the American members of the commission which drew up those sections of the peace treaty which set up the International Labor Office. By profession a banker (president of the First National Bank of Los Angeles), he has interests in many industrial enterprises, and brings a broad comprehension of business problems.

Norman H. Davis has been almost continuously in the public eye in international affairs since the war. With a record of long business success, chiefly in enterprises in Cuba, he entered war work in connection with foreign loans in 1917. This took him to Europe, where he remained until after the Armistice, serving as a member of the Armistice Commission, as a member of the Supreme Economic Council, as financial adviser to the President in the negotiation of peace, and subsequently as a member of the Reparations and Financial Commission. Later he was assistant secretary of the treasury and under-secretary of state, going to Europe afterwards as chairman of the League of Nations committee to determine the status of the territory of Nemel.

Dr. Alonzo E. Taylor, of Leland Stanford, agricultural expert, was examiner of prison camps in Germany, attached to the American Embassy, during 1916, and then in 1917 was in charge of the blockade provisions on foods and chemicals. Following the Armistice, he surveyed conditions, with an eye to the needed relief, in Austria, Hungary, Poland and the Balkans, remaining in relief work until 1921.

Dr. Julius Klein's experience in building up our foreign trade service is well known and has given him an unusually thorough knowledge of foreign conditions. John W. O'Leary's position as president of the U. S. Chamber of Commerce is proof sufficient of the opinion held of him by the business men of this country, and evidence of his competence to help in a conference of this sort.

Traveling with the delegation, bound for Geneva, not as a representative of the U. S. Government but of the International Chamber of Commerce, is Roland W. Boyden, of Boston. His qualification for the assignment is indicated by his three years' service on the Reparations Commission (from April, 1920, to August, 1923). During this period, also, he was a delegate to the Brussels Financial Conference, representing the U. S. Treasury Department. Last year he was in Europe as a delegate of the International Chamber of Commerce on the Preparatory Committee which outlined and arranged for the forthcoming Geneva meeting.

The experts attached to the delegation are all qualified by long experience and all of them, too, are familiar with foreign conditions by study abroad. It would be invidious and unfair to single out one or two of them for mention, and space does not permit of the mention of the experience of all; but reference may be permitted to the labor expert, the veteran leader, John P. Frey, close associate of Samuel Gompers, and valiant champion of labor interests but of soundness and moderation as well. His contact with international labor matters began as far back as 1909, as a delegate from the A. F. of L. to the British Trade Union Congress. Twice during the war he was sent abroad on labor matters.

Such is the experience of the delegation that America is sending to Geneva.

Study of Problems—The seriousness with which the group is taking its committed task is evidenced by the thoroughness of its preparatory work. A dozen committees labored in Washington for several months compiling data. On the boat there have been two meetings a day, through good weather and bad, for discussion of the data and clarification of views. Even now, on the last day out, the sessions are still going on. As a result of these meetings one can sense the feeling that matters are well in hand and that the delegation and its experts will enter the sessions with confidence of their readiness to make a satisfactory American contribution to the Conference.

The data prepared, one gathers, fall into three

classes: (1) America's economic conditions and industrial experience; (2) our knowledge of and data on conditions and experience of foreign lands; and (3) barriers and hindrances to foreign trade and to healthy industrial functioning.

Attitude of Delegation—The meetings on shipboard have been private and no statements have been made regarding decisions on policy. But the attitude of the delegates, as revealed in general conversation, is clear. America is going there with no program. It is Europe's show. If they present any plan, the American delegation will consider it carefully, and accept it if our laws, policies and conditions permit. If plans that are proposed have been tried here, our delegates will tell whether they have worked with success or not. The delegates, of course, cannot bind our country or government.

To put it in another way, the attitude of our delegation seems to be to help as the Europeans want our experience and help, but not to tell the Europeans what to do. The attitude seems to be that the whole world can be made more prosperous without detracting from the prosperity of anyone—on the same principle that obtained in the earlier days of the automobile, for example, when the competition for business resulted not in stealing trade one from another but in developing more trade for all. There is a sincere desire to see Europe restored to full industrial vigor.

At the same time, these stalwart Americans can be counted on to defend the rights and position of our country and its business interests stoutly and adequately.

America's interests are in good hands.

* * *

Geneva, Switzerland (by cable)
May 5, 1927

The International Economic Conference at Geneva opened on May 4 with 47 countries including Soviet Russia represented by delegates.

The first four days were devoted to a survey of the world's economic ills. There was general agreement that increased production was the indicated remedy, thereby increasing purchasing and consuming power and raising the standard of living. A striking note was the general solicitude for the well-being of workers, which was probably a new idea with European employers. The keenest analysis of the situation was made by W. T. Layton, editor of the *Economist*. He contended that we could not return to pre-war conditions. In his opinion a new equilibrium must be established due, first, to the great increase of industrialization; second, to the fact that the United States is now a creditor nation but apparently does not desire to buy from the countries she finances, contrary to the policies of former financing nations; third, to the decrease of European emigration; and fourth, to the alteration of trade relations resulting from the payment of reparations and international war debts. The situation is more acute because Russian imports are small and Central Europe is divided by high tariff walls, resulting in duplication of industrial plants and preventing specialization which is the essential feature of our modern industrialism.

Mr. Layton's insistence that the tariff walls of Central Europe must be lowered was approved by numerous speakers. There also was general approval of tariff stabilization regardless of the level, thus encouraging long-time contracts, uniform tariff classification and nomenclature. Long-time commercial treaties were advocated. There was no reference to American tariff rates but several indirect references to our prohibition of immigration. Financing of backward countries was urged to stimulate production.

Dr. Von Siemens, of Germany, criticised government intervention in industry, which was particularly interesting as coming from the representative of a country where government assistance and compulsion are considered normal. Zimmerman, of Holland, cited increased government services and restrictive labor legislation as increasing the industrial burden by raising prices, restricting consumption and reducing trade. The remedies suggested were removal of government interference and reduction in number of non-productive public servants. Only Shidachi, of Japan, and Layton, of Great Britain, have cited the wastefulness of armaments.

The speech of Henry M. Robinson, chairman of the American delegation, was well received. He sketched the development of our prosperous industrial situation, stressing the determination of American employers to secure needed economies by better management and machinery, but not by wage reduction. He affirmed the American belief that competition stimulates industrial progress and suggested that the American delegation would probably disapprove of international cartels if governments participated or if they were exploitive in character. Answering Sir Max Muspratt, of England, who thought that rubber restriction bore equally on everyone, Mr. Robinson contended that there was discrimination against America which uses 75 per cent of the output as against only 7 per cent used by Great Britain.

Sokolnikoff, of Russia, painted an optimistic picture declaring that industrial and agricultural production are now in excess of pre-war outputs, but the figures are doubted here. He made a strong plea for closer capital and trade relations, contending that the capitalist and socialist systems can work harmoniously together. He protested the boycott of Russia.

Obolenski Ossinski, of Russia, criticised the capitalist system severely, declaring it to be the cause of the World War. He accused it of glaring inconsistencies such as longer working hours while unemployment continued on a large scale. He condemned cartels and repeated Sokolnikoff's plea for trade relations, emphasizing the importance of the Russian market. In conclusion he offered eleven suggestions for restoring world trade and prosperity: (1) Cancellation of war debts; (2) increase industrial wages; (3) eight-hour day for all workers except miners, who should have six; (4) fullest liberty for trade union organization and complete liberty for strikes; (5) relief for the unemployed; (6) raise funds for the unemployed by taxation; (7) decrease unproductive expenditure, especially for armaments; (8) abolish barriers against immigration; (9) cancel protectorates and mandates and permit self-determination for all peoples; (10) no intervention in China; (11) suspend economic boycott on Russia and extend credits to that country.

From Job and Office

Hints That Cut Cost and Time for the Contractor and Engineer

Launching and Hoisting an Elevated Pipe Bridge

By Warwick R. Jewel
Consulting Engineer, Buffalo, N. Y.

Ice difficulties led to the adoption of a quite unusual method for erecting a bridge to carry gas pipes across the Buffalo River near the intersection of Seneca and Elk Sts., Buffalo, N. Y. The structure has a clear span of 250 ft. and clear height of 100 ft. above river level; it is supported by rigid towers 10x18 ft. in ground plan and 104 ft. high. The bridge trusses, 14 ft. deep, are spaced 18 ft. apart.

Originally it was planned to assemble the trusses separately on the bank in upright position and push each truss across the river step by step as its assembly proceeded, using a temporary erection tower in the middle of the river as a support in this launching process. This tower would also serve as a hoisting tower in raising the trusses and would hold them until the lateral bracing could be put in place. A 114-ft. steel temporary tower accordingly was built on pile foundation in the middle of the river and it was expected to assemble, launch and hoist the trusses in the fall, before ice in the river could give any trouble. Unfortunately, delays occurred which pushed the work into the winter, and on Dec. 12 the river ice, which had formed early,

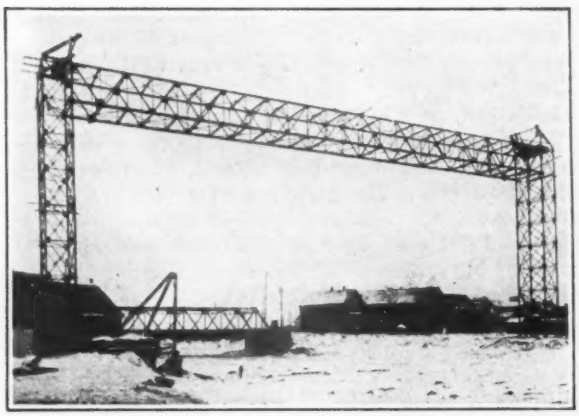


FIG. 1—BUFFALO RIVER PIPE BRIDGE

went out during a warm rain accompanied by high wind, and the erection tower was carried away.

It was believed important even at some risk to build the bridge and get it into service before spring, in spite of this unforeseen difficulty, to insure Buffalo's gas supply against interruption. Accordingly a method for erecting the bridge without the use of a central tower was developed. It was carried out with entire success. The sketch illustrates the method adopted.

Launching and hoisting the trusses separately was, of course, out of the question, as they would be without the lateral support which the temporary tower had originally been intended to give. In the revised plan, therefore, the span was to be erected as a whole, and launched forward while assembly was progressing at its rear end, the forward end of the truss being supported and pulled by a cable let down from the top of the far tower.

In preparing for carrying out the erection, the far tower was rigged carefully, as it had to do the lion's share of the work. Guy lines were run from the top

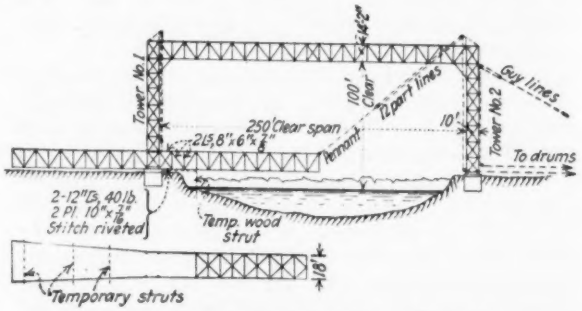


FIG. 2—ARRANGEMENT FOR LAUNCHING
Erected on land, slid forward with nose held by cable from far tower, and hoisted to place.

of the tower to deadmen about 150 ft. back; being connected to the tower through sheave blocks with lead lines carried to the drum of a hoisting engine they were adjustable and would be kept under control. With this arrangement advantage was taken of the stiffness of the tower to cushion the shocks on the guy lines, and the distance between towers was under control to make the connection after the span was raised. The near tower was rigged with hoisting falls.

The trusses were assembled upright on either side of the near tower. As there was not sufficient room back of the tower to accommodate the whole length of the trusses, when about 200 ft. of the length had been assembled and riveted they were moved forward toward the river and the ends cantilevered out over the water about 70 ft. The trusses were now completely assembled and the lateral system in front of the tower was filled in.

Before starting the launching, additional support and stability were provided by building a wooden bent under the span about 30 ft. out from the tower; this had to be put down by digging out and removing 20 tons of ice and then bringing the full weight of the end of the span to bear on the bent to force it to place.

When the launching was begun, it went ahead so satisfactorily that the entire span was taken across the river in one day, although stops had to be made every 10 or 15 ft. to permit of adding laterals. The span, weighing about 95 tons, was supported on rollers under the bottom chord, which was made of two 12-in. channels back to back, with reinforcing plates. The horizontal pull of the lines from the top of the far tower was sufficient to move it. Snubbing lines fastened to the base of the near tower kept the movement under control. By proper handling of these snubbing lines the movement became almost automatic.

When the span was entirely across the river its full

lateral bracing was in place and therefore it was ready to be hoisted and fastened in final position. The hoisting presented no particular problem but required careful rigging on account of the size and weight of the span. Four hoisting engines handling 12-part ¾-in. lines were used. As the drums would not accommodate the amount of line necessary for a full lift, the hoisting had to be stopped halfway up for rerigging, as provided for.

This work was carried out by the Frank Sweet Structural Steel Co. of Buffalo, under the direction of George C. Holcomb, vice-president, for the Iroquois Gas Corporation.

Unusual Construction Method Used by New Zealand Contractor

LARGE circular concrete tanks for a sewage plant being constructed in New Zealand were erected above the ground level and then sunk into position by T. Pheloung, a contractor, of Christchurch, New Zealand. Each tank measures 30 ft. inside diameter by 22 ft. in height. After the tanks were constructed the ground was excavated inside of the tanks and the concrete structure settled into position. The settling process was hastened by placing heavy railroad rails upon the walls of the tank. The contractor reports that he has been able to sink one of these tanks to ground level

CONCRETE SEWAGE TANK BUILT AND SUNK TO PLACE

or to a depth of 22 ft. in 7 hr. of actual working time. Four tanks have been placed, and more will follow.

The material was excavated with a clamshell crane mounted on continuous treads. During the excavation, trees were found embedded in the clay in large numbers, evidently the remains of a submerged forest.

The foregoing was called to the attention of the Osgood Co. who furnished the crane used on this job.

Soil Loading Test Platform Held Against Tipping

By Elwyn E. Seelye
Consulting Engineer, New York City

IN making soil tests the engineer experiences considerable difficulty in balancing his load platform on a 12 x 12 timber. Common methods of achieving this

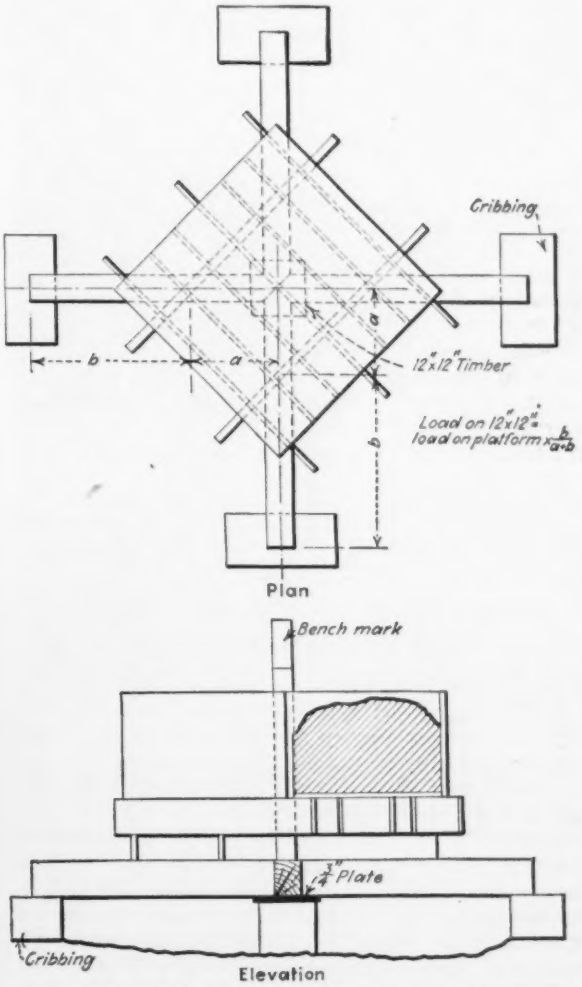


FIG. 1—LOAD TEST PLATFORM CARRIED ON FOUR LEVER BEAMS

are guying the platform, jacking under the corners of the platform, and shifting the load so as to keep the center of gravity within the area of the plunger. All are more or less unsatisfactory. The plunger is continually subject to trapezoidal and triangular load distribution which results in inaccuracies in determining the resistance of the soil. Also in many cases the platform gets out of hand and tips over.

For this reason the author has developed the type of platform which is shown in Fig. 1. It will be seen that the loading block is steadied by the four lever beams on which the loading platform is supported and whose outer ends rest on fixed blocking. An illustration of the application of this platform is shown in the photograph Fig. 2, a load test in the basement of the Independence Trust Building at Charlotte, N. C., where the addition of extra stories

required soil investigation. Under this arrangement there was developed a steady downward pressure on the plunger even though the total settlement amounted to 3 in. under a test load of 8 tons per sq. ft. The architect on this alteration was W. L. Stoddart and the structural engineering was handled by the author.

FIG. 2—TEST LOAD ON FOUNDATION SOIL IN CHARLOTTE

Freight Yard Fill Material Conveyed Over Road and Railway

HANDLING excavated material by belt conveyors from the pit across a highway and main-line railway to load dump cars on the other side of the tracks was the method employed in filling a 100-acre tract for the new freight yards and engine terminal of the Wabash R.R. at North Kansas City, Mo.

Material for this fill of 600,000 cu.yd. was obtained at a point nearly a mile distant, but the haul involved the crossing of a busy double-track railroad and a highway paralleling the railway right-of-way. To operate dump-car trains meant the construction of a long high trestle and inclined approaches, in order to give the legal 22-ft. headroom over the tracks. Under the plan adopted, the steam shovels loaded a hopper feeding a short apron conveyor which delivered the material to the lower end of an inclined or elevating conveyor 100 ft. long. This in turn discharged onto another 100-ft. conveyor which spanned the highway and tracks and was slightly inclined so as to give a clear headroom of 15 ft. above the road and 22 ft. above the rails. At the end of this second conveyor, the material was discharged into a hopper with chute for loading the 12-yd. dump cars, which were hauled in trains to the site of the yard.

The second conveyor was carried by a light steel truss bridge mounted on towers having grooved wheels riding on rails, so that as the excavation advanced, parallel with the road and tracks, the conveyor could be moved forward. As the bridge had pivoted supports, the tower at the discharge end could be moved independently of the other. The first conveyor was pivoted at its upper or discharge end, and its lower end could be swung horizontally to keep within convenient reach of the loading hopper. The conveyor belts were 36 in. wide, driven at about 300 ft. per minute by electric motors of 30- and 20-hp. for the first and second conveyors, respectively.

This grading and filling contract was handled by the Carmichael-Cryder Co., St. Louis, Mo.

From Job and Office

Hints That Cut Cost and Time

Simple Means of Leveling Grillages

BY H. M. NAYLOR
Office Engineer, Kansas Power & Light Co., Topeka, Kan.

STEEL I-beam or channel grillages for the distribution of column loads to concrete substructure must be set very carefully and accurately to grade in order to insure the exact location of the columns. Such grillages are very commonly set with iron wedges, after which both grillages and wedges are grouted in. The fault with this method is that the ends of protruding wedges are very easily kicked, resulting in the dislocation of the grillage and requiring that it be reset. Furthermore, the grillage is frequently surrounded by a network of reinforcing steel, making the leveling wedges difficult of access.

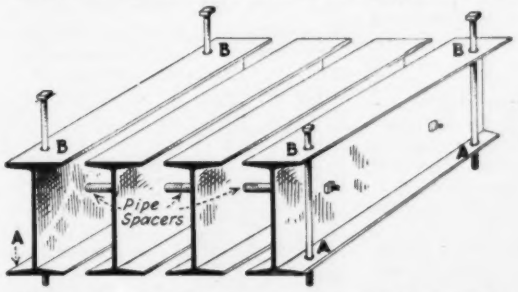
A cheaper, more substantial and quicker method of

BELT CONVEYORS SPANNING ROAD AND RAILWAY HANDLE 600,000 CU.YD.

From Job and Office

For Contractor and Engineer

leveling grillages is to provide each with a set of four leveling screws as shown in the accompanying sketch. The bottom holes at *a* are drilled and tapped to receive



GRILLAGE PROVIDED WITH LEVELING SCREWS

the threaded portion of the bolts, the latter extending up through the guide holes *b* which can be made satisfactorily with a cutting torch.

If the projecting bolt heads constitute an obstruction after the grillage is grouted in place, they can be cut off with a torch.

Culvert Jacked Beneath Pavement by Novel Method

By F. E. Wilson
County Engineer, El Paso County, Texas

IN EL PASO County, Texas, as in other counties in an irrigated district, it is necessary almost constantly to install culverts under existing roadways. Concrete and gravel surfaces and heavy traffic add to the difficulties of the problem. The method of opening half the roadway width at a time causes inconvenience to the public and in addition may permanently injure the roads. With these facts in mind, the writer has for some time been considering various methods for placing culverts under roads without the need for cutting the pavement.

Recently a culvert installation supplied the opportunity for trying out a new method which did not disturb traffic or the pavement of the roadways. The method, essentially one of jacking, included the use of an old automobile engine with the drive shaft extended to a length equal to that of the culvert to be installed; cutting blades were attached to the end of the shaft and slightly outside the end of the culvert. The shaft was centered in the pipe by means of blocking at four different places. To carry the dirt back through the pipe from the cutting blade a 9-in. screw conveyor riding in a smooth 16-gage sheet metal form was placed in the bottom of the culvert. The conveyor was chain driven from the engine drive shaft.

FIG. 1—JACKING CULVERT BENEATH PAVEMENT AIDED BY ENGINE-DRIVEN CUTTING BLADE

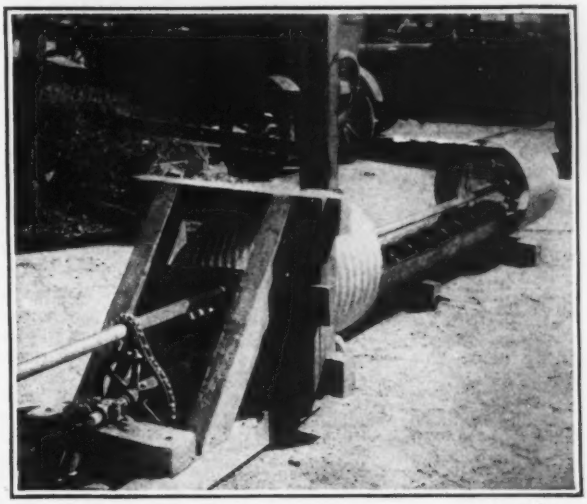


FIG. 2—SET-UP OF DIRT HANDLING APPARATUS OF CULVERT JACKING RIG

In using the equipment, a trench was dug outside of the pavement large enough to hold the engine and the length of culvert pipe. The whole installation was placed on a skid track in the bottom of the trench and the pipe pushed up against the embankment by means of blocking and a 3-ton track jack. As the dirt was cut away and removed by the conveyor the jack maintained the pressure of the cutting blade against the face. The dirt coming back through the culvert pipe was shoveled out of the trench.

After this first installation, it was found that a few minor changes would improve the efficiency of the equipment. First, the main shaft should not be driven direct from the drive shaft but should be geared down; the engine used in this case had a speed of between 550 and 600 r.p.m. Second, the shaft should carry a second set of cutting projections, heavier than the blades used and of smaller cutting diameter, to be placed in front of the cutting blades for roughing out the opening. Third, a flywheel should be used on the shaft. Pipe placed on this first installation was 24 in. in diameter and 26 ft. long. The plan and equipment were worked out by C. A. Campbell, a well drilling contractor of El Paso. Mr. Campbell has made application for a patent on the equipment.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

San Francisco Bridge Board Selects Three Sites

Preferred Location Extends From Rincon Hill to South Side of Alameda Mole

The board of engineers retained by the city of San Francisco to "investigate and report on the three best locations" for a bridge across the bay between San Francisco and Oakland has turned in its report. The board consisted of Robert Ridgway, A. N. Talbot and John D. Galloway. Announcement of their appointment and instructions appeared in *Engineering News-Record*, March 3 p. 374. and Mar. 31 p. 541.

The preferred site which, strangely enough, has not been named by applicants for franchises although the second and third-choice locations have been named by several applicants, is from Rincon Hill on the San Francisco side, to the south side of the Alameda mole with a looped track for interurban service in San Francisco and, on the east end, branch routes to important traffic lanes. The second choice is from Potrero Point at Twenty-second St. on the San Francisco side to the foot of Pacific Ave. in Alameda. This location is considerably longer than No. 1 but is so situated that it is possible to use the same arrangement for handling traffic at both terminals. The third choice is from Telegraph Hill to the Key Route mole in Oakland, via Goat Island.

Location No. 1, the report says, offers the most direct route, is conveniently accessible to all existing interurban lines, land values on Rincon Hill are not high, no obstructions are placed across Oakland harbor, and there is no interference with the projected Alameda harbor or the proposed Alameda naval base, the ferry lanes are left free and any future rapid-transit system can be readily diverted to its terminals.

For a distance of 12,000 ft. from the San Francisco side the bridge would be 150 ft. above mean high water and would include two 1250-ft. spans, the others ranging from 500 to 750 ft. long. Two decks are recommended, the lower to have three rapid-transit tracks and the other a 42-ft. roadway with a capacity of 4,000 to 5,000 vehicles per hour. The report recommends against provision for main line trains.

The traffic loop on the San Francisco side provides for several stations in an area of 7 squares long by 3 squares wide, as well as for automobile control and receiving space. On the eastern end, two tubes would be built under the Oakland estuary from a solid fill on the south side of the Alameda mole to provide for northbound traffic.

With reference to foundations, the report stresses the meager information now available on the conditions in the Bay bottom and points out that the construction of piers must be expected to present great difficulties and to be extremely expensive. Before the design of a bridge is begun a thorough investigation of the Bay bottom by borings is recommended because it is possible that conditions may be so unfavorable that the cost of the proposed structure would be prohibitive. Much the same comment as to foundations applies to location No. 2 which has, however, features that make it less desirable.

Recommendations appended advise that (1) Permission be obtained from the War Department to build a bridge at location No. 1 and (2) that the site be explored by boring, after which a design and cost estimates can be made.

May Revise Chicago Building Code

For a revision of the Chicago building code, to bring it in line with modern conditions, the city commissioner of buildings has called a conference of about twenty engineers, architects and contractors, to organize a committee for the study of the present code and suggestion of changes. These changes will then be considered by the committee as a whole and finally discussed with the officials of the building department.

Engineering Fifty Years Ago

From *Engineering News*, May 12, 1877

A PORTION of the roof of the new Post Office in New York fell on May 1. A brick cross-wall which had previously supported a portion of the roof had been cut away and an iron truss had been substituted, timber struts meanwhile having been used to support the superincumbent weight. On the completion of the work and the removal of the timbers, the truss immediately yielded under the load and some 20 feet by 30 feet of the roof fell in, burying four of the laborers in the ruins, and causing the death of three of them. The truss was supposed to be similar to another already in use, and to be as strong. The roof was made of iron beams, carrying arches of corrugated iron, leveled up with concrete and thus protected on the outside with sheets of copper, thus making a fireproof roof. The concrete was some three inches thick on the crown of the arches, upwards of a foot thick at their springings, and the whole weight is stated to have been 100 lb. per sq.ft.

Ira H. Woolson Dies in Chicago

Was Attending Building Officials Conference—Long Prominent in Materials Testing

Ira H. Woolson, consulting engineer of the National Board of Fire Underwriters, died in Chicago on May 8, in his 71st year. He had been in Chicago speaking before the Building Officials Conference held there the week before and was stricken on the street while taking a stroll after an evening meeting. He was removed unconscious to a hospital where he succumbed the next day.

Professor Woolson was born in Lewiston, N. Y., Aug. 11, 1856, and was graduated from Columbia University with the degree of engineer of mines in 1885. He soon entered the faculty of Columbia, first as an assistant in assaying and in drawing, and later as instructor in mechanical engineering, and finally as professor of civil engineering. In 1910 he left the university work to become consulting engineer of the National Board of Fire Underwriters. During the latter years of his university career he established at Columbia the fire testing station which was one of the pioneers in the country. For 20 years he was in charge of the general testing laboratory at the university which not only undertook the study of fire resisting materials but also became one of the best known research and commercial laboratories in the country. In connection with his fire-resisting laboratory he developed a number of the now standard methods for fire testing.

He had been official investigator of building materials for New York City for 10 years, was advisory engineer to the Building Materials Division of the War Industries Board during the war, and since 1921 had been chairman of the Building Code Committee of the United States Department of Commerce, the committee which had devoted so much study to the subject of building codes and regulations. For years he had been particularly active in the American Society for Testing Materials, the American Concrete Institute and the National Fire Protection Association.

Plan Subways for St. Louis

A bill has been introduced in the Missouri legislature to permit the city of St. Louis to undertake the construction of rapid-transit subways, a portion of the funds to be provided by special assessment.

Flood Problems Considered by Drainage Congress

Handling Drainage, Irrigation and Flood-Control Projects Are Three Main Subjects

Following the precedent of its 1926 meeting at Oklahoma City in concentrating attention on the Arkansas River, the National Drainage Congress at its fifteenth annual meeting, held at Amarillo, Tex., on April 21 to 23, threw the weight of its influence toward the development of the Canadian River flood-control project. A review of the history of this project, which is of an interstate character, was presented by A. S. Stinnett, Texas commissioner for the Canadian and Red rivers. A resolution was adopted endorsing the plan for a tri-state compact between Texas, Oklahoma and New Mexico as the best machinery through which Congress can grant federal co-ordination in legislation and financial aid toward constructing dams and carrying out the scheme of stream control. As to the Colorado River interstate project, Congressman Morrow, of New Mexico, stated that with the seven states united in backing a single movement, Congress is likely to act favorably on this project.

Malaria Control

In discussing malaria control, H. W. Van Hovenberg, sanitary engineer of the St. Louis Southwestern Ry., gave great credit to the railways in helping to rid the country of a public health menace which often handicaps industrial activities and renders fertile lands uninhabitable and unprofitable. He indicated that drainage, to be effective from a health standpoint, must provide for the complete removal of storm water, so as to eliminate pools. In regard to soil erosion, Lucien Wright, Portland Cement Association, said that small dams can be used to good advantage in farm projects. Referring to conditions along the Illinois River, W. G. Potter, assistant engineer of the Illinois State Division of Waterways, said that many of the districts inundated in 1925 and 1926 are still under water and will be unable to produce crops. The flood of 1927 reached an even higher point, with its chief damage to the city of Beardstown. Several drainage districts having gone through the 1922, 1926 and 1927 floods are unable to tax the property high enough to make repairs, while many farms will be lost to their owners on account of the inability to make payments due for taxes on land.

In opening the meeting, the president, Roy N. Towl, Omaha, Neb., remarked that too much attention had been given to hacking at the trunk of the tree, while the proper approach to flood control is by cutting off the branches. This was the keynote of the discussions. A proposed combined dam and railroad crossing on the Canadian River was outlined by Charles A. Morse, chief engineer, Rock Island Lines; while Webster L. Benham, Kansas City, described the Lugert Dam (see *Engineering News-Record*, April 21, p. 655). Other papers included the following: "Sidehill Drainage," Prof. E. R. Jones, Wisconsin state drainage engineer; "Irrigation of the Great Plains," A. Lincoln Fellows, U. S. Department of Agriculture; "Diesel Engines for Pumping," J. E. Pottharst, Three Rivers, Mich.; "The Drainage Situation in Minnesota," E. V. Willard, state commissioner of Waters; "Interstate Compacts to Aid National Developments," E. E. Blake, Oklahoma Reclamation Commission; "Coast and Bank Protection Works," F. D. Tomson, Lincoln, Neb.; "Organization of Drainage and Reclamation Districts," Ireland Hampton, Fort Worth, Tex.; "Methods of Flood Control," L. K. Sherman, Chicago.

A proposed information service to be undertaken by the association, with the assistance of other drainage interests, was noted by Edgar A. Rossiter, Chicago, as part of the plans for the coming year. Resolutions were passed urging action by Congress for the control and utilization of flood waters, and urging appropriations to permit progress with the hydrographic investigations of the U. S. Geological Survey.

Officers of the National Drainage Congress for 1927-1928 are as follows: President, Edgar A. Rossiter, consulting engineer, Chicago; vice-presidents, J. L. Tremper, Streator, Ill.; Frank D. Tomson, Lincoln, Neb.; A. S. Stinnett, Amarillo, Tex., and E. E. Blake, Oklahoma City, Okla.; secretary (re-elected) C. R. Thomas, Chicago.

Mississippi Floods Now Threaten Southern Louisiana

Crest Below Natchez—Serious Conditions at Atchafalaya Cut-Off—New Orleans Stage Falls Slightly

WITH the crest of the Mississippi flood passing Natchez, the most serious situation on May 11 was the probable breaching of the levees at the head of the Atchafalaya River and the possible flooding of a large area of Southern Louisiana, known colloquially as the "Sugar Bowl." As shown in the accompanying gage table, the river is falling everywhere north of Natchez and the most critical danger is thought to be passed above the city. Backwater in the St. Francis and Tensas basins continues to flow toward the mouth of the basins and the waters from the flooded Yazoo district are reaching the Mississippi at Vicksburg. Conditions in these sections are reported below in telegrams from the engineer officers along the river.

The critical point at the head of the Atchafalaya is a famous part of the Mississippi control system. Here the Red River flows into the Mississippi near the head of the Atchafalaya River and there has been established a cut-off, with the so-called Atchafalaya Sill, which permits part of the flood flow of the Red River to pass down the Atchafalaya, the remainder flowing across the so-called Old River into the Mississippi. The country lying below this junction is guarded by the Bayou des Glaise levees and as reported in Major Holcombe's dispatch these latter are lower than the Atchafalaya flood heights approaching them. If they fail a large part of the flow of the Red River will pass south through the Atchafalaya valley to the Gulf.

There is given herewith a diagram showing the gages in the lower valley for the past ten days. Since this was drawn, the Red River at Alexandria has reached its crest. It will be seen from this diagram that the Caernarvon Crevasse caused no change in the gage height at New Orleans, though it may have restrained the flood from rising at that point. A telegram from Roger B. McWhorter, dated May 10 says: "Blasting discontinued at Caernarvon May 9. Clear opening of 2,700 ft. Thirty-five tons dynamite used. Discharge not measured as yet but probably over 200,000 sec.-ft. based on known depths and approximate velocities. Situation entirely satisfactory."

Following are the dispatches from the Vicksburg and New Orleans officers

Baltimore Voters Approve Loans Aggregating $47,500,000

Public improvement loans totaling $47,500,000 were approved by the voters of Baltimore at a municipal election held on May 3. Of the total amount thus made available, $10,000,000 will be used for new schools; $10,000,000 for water supply extensions (a large part of the money to be spent to provide mains); $10,000,000 for sewers, including storm-water drains; $6,000,000 for paving; $2,000,000 for bridges and the elimination of grade-crossings; $1,000,000 for conduits; $4,000,000 for buildings, providing for new construction at the Baltimore city hospitals, erection of new units at Sydenham Hospital and the construction of new police and fire department stations; $3,000,000 for the construction of a new central building for the Enoch Pratt Free Library, and $1,500,000 to provide a flying field.

School and water expenditures will be made under the supervision of the Public Improvement Commission and the others under the various municipal departments and the chief engineer.

San Francisco to Vote June 14 on Water-System Purchase

The San Francisco board of supervisors has set June 14 as the date on which to vote on the proposed $40,000,000 bond issue for purchasing properties of the Spring Valley Water Co. There will be at least two other proposed bond issues on the ballot, namely, $4,700,000 for municipal railway extensions and $1,400,000 for the Bernal cut improvement.

GAGE HEIGHTS AT LOWER MISSISSIPPI VALLEY POINTS

	Mississippi River						Red River	
	St. Louis	Memphis	Vicksburg	Natchez	Baton Rouge	New Orleans	Shreve-port	Alex-andria
Flood stage*...	30.0	35.0	45.0	46.0	....	17.0	29.0	....
Provisional Levee grade**	....	51.5	58.0	57.5	48.1	25.2	....	....
1922	34.0	42.5	54.8	55.3	45.7	21.3	....	....
Previous high.. 1927	41.4	46.5	53.8	53.5	43.8	21.1	....	....
April 24	35.6	45.9	54.8	55.3	44.8	20.8	34.1	....
April 25	35.8	45.9	54.5	55.2	45.0	21.0	35.1	38.0
April 26	36.1	45.6	54.4	55.0	45.0	20.9	36.0	38.3
April 27	35.6	45.4	54.9	55.0	45.0	20.8	36.7	38.7
April 28	34.6	45.1	55.7	55.1	45.0	20.8	37.2	39.0
April 29	33.4	44.7	56.3	55.5	45.1	20.8	37.4	39.5
April 30	....	44.3	57.2	56.1	45.4	20.8	37.4	40.0
May 1	....	43.8	57.9	56.5	45.8	20.7	36.9	40.5
May 2	....	43.2	58.2	56.4	45.7	20.7	36.4	40.1
May 3	....	42.7	58.5	56.4	45.4	20.4	35.4	41.3
May 4	26.8	42.2	58.7	56.5	45.6	20.4	34.3	41.5
May 5	25.4	41.6	58.2	56.4	45.7	20.4	32.6	41.9
May 6	24.1	40.8	58.0	56.1	45.8	20.4	31.9	42.1
May 7	23.7	40.6	57.7	55.7	46.0	20.3	29.2	42.3
May 8	25.4	39.8	57.2	....	46.1	20.3	27.6	42.4
May 9	27.3	39.2	57.0	55.3	46.1	20.3	26.1	42.2
May 10	29.5	38.4	56.6	55.1	46.3	20.2	24.6	41.9

* Approximately a bank-full condition above which levees are required.
** Grade established by the Mississippi River Commission as the desired height for the levees.

of the Mississippi River Commission, both dated May 10:

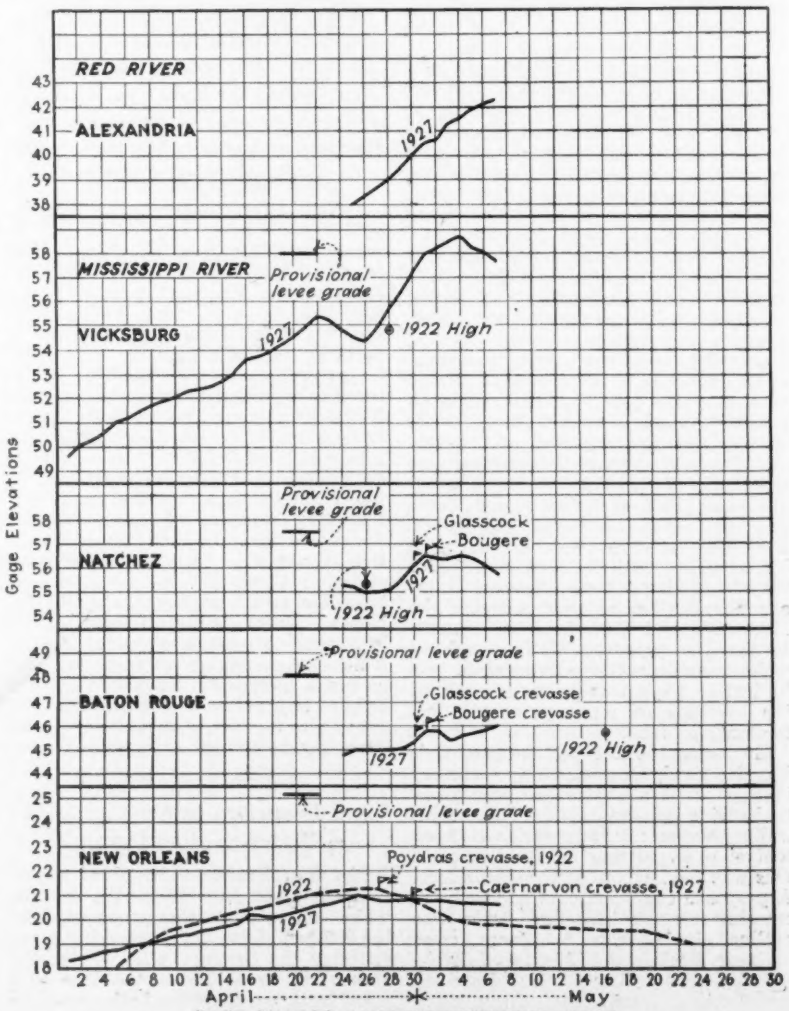
Maj. John C. H. Lee, Vicksburg:

"The flood situation in the Third Mississippi River Commission district on May 10 has improved during the week. Danger of further crevasses in levees has been entirely passed except along the extreme lower 15 miles in Louisiana. This reach is immediately below the Cabin Teele (Milliken Bend) crevasse and is just opposite Vicksburg. The water returning to the river from the Stopps Landing crevasse in Mississippi through the Brunswick Gap and the mouth of the Yazoo is holding the Vicksburg gage at a dangerously high level. The stage today is 52.6 ft. which is still 1.8 ft. above the 1922 high water level. The overflow conditions are improving in the upper end of the district in Arkansas and Mississippi. The backwater at Arkansas City has a total fall of 4.1 ft. and is falling at the rate of about ½ ft. daily. At Greenville the total fall is 1.6 ft., the rate of fall being about 0.1 ft. daily. The more rapid fall in Arkansas is a result of the Arkansas River crevasses practically ceasing to flow because of the reduction of water level in the Arkansas River to below the bank full stage. The overflow in Madison Parish, La., as a result of the Cabin Teele crevasse is gradually spreading over the entire south end of the Parish and into Tensas Parish. At Monroe on the Ouachita the protection levee around the city has been held. The Arkansas River crevasse waters, together with excessive rains in the Ouachita drainage basin, have combined to cause flood stages approximating and exceeding in many places any previous records. The overflow conditions are worse than ever before experienced in the lower Tensas and Boeuf Rivers."

Maj. W. H. Holcombe, New Orleans:

"Levee breaks reported at west bank at Cabin Teele 15 mi. above Delta, La., and at Winterquarters, 15 mi. above St. Joseph, La. Cabin Teele now 1,500 ft. wide. Winterquarters, 300 ft. wide. Crevasses so far all discharging into Tensas basin. Increasing volume discharging through crevasses in Arkansas River and as previously reported at Bougere and Glasscock. Tensas basin closed off near junction of Red, Atchafalaya and Mississippi Rivers by levee lines along Bayou des Glaises. Flow was deflected down Atchafalaya River till May 9 when current in Old River reversed toward Mississippi. Hereafter crevasse water will split at Old River flowing down both Atchafalaya and Mississippi Rivers. Atchafalaya River fast reaching capacity of levee lines, the grade of which on Bayou des Glaises is from 3 to 4 ft. lower than crevasse crest wave. Reverse flow through Old River into Mississippi increasing hourly. Swelling crest in main river passing that point and expected to raise stage 3 ft. at Angola and Baton Rouge, 2½ ft. at Plaquemine and Donaldsonville and 1 ft. at New Orleans. A crevasse in Bayou des Glaises expected hourly may flood Atchafalaya basin, diverting considerable upper crevasse water to Gulf without return to Mississippi River and slightly lowering anticipated stages. Levees along west bank Mississippi River from Old River down in good shape to stand maximum stage anticipated. Levee along east bank from Baton Rouge down sandbagged to anticipated stage."

Cabin Teele crevasse, noted in Major Holcombe's dispatch, is the one referred to as Milliken Bend in the report in these columns last week. So far as the records show, there has been only one new crevasse in the Mississippi system in the past week, that at Winterquart-



GAGE CHARTS, LOWER MISSISSIPPI RIVER

The days upon which levee breaks occurred are shown upon charts which they effect. Provisional levee grade shown is that established by the Mississippi River Commission. All levees are not up to this grade.

ers on the west bank, 15 miles above St. Joseph, La.

Major-General Jadwin, chief engineer, has addressed the following latter to Col. C. L. Potter, President of the Mississippi River Commission:

"The Chief of Engineers requests that the Mississippi River Commission revise its plans, estimates of costs, and time of completion for the project for the Mississippi River and its tributaries and outlets, to provide with a reasonable factor of safety for any probable flood on the Mississippi. This revision should include for flood control purposes the tributaries and outlets to the extend necessary to insure against possible overflow and damage by water from, or backwater caused by, the Mississippi. It should also include a study of any modifications desirable in the plans for improving the low water navigation and the stabilization of the Mississippi between Cairo and the head of the Passes.

"He desires to secure your report revised as above by Oct. 1, 1927, and if practicable, partial reports prior to that date. He also requests at an early date a preliminary report giving the river stages at critical points on which the flood control project is to be based, and a statement of the methods of which these stages have been calculated.

"This has the approval of the Secretary of War and is in accord with the wishes of the President."

Museum of Engineering and Industry Holds Meeting

The National Museum of Engineering and Industry held its third annual meeting at its headquarters in the Engineering Societies Building, New York City, on April 28, at 4 o'clock. Preliminary to the meeting the members tendered a luncheon at the Engineers Club to the presidents and secretaries of eleven scientific and engineering societies who were represented on its board of trustees.

The following trustees were elected: L. P. Alford, B. C. Batcheller, George M. Bond, Nicholas F. Brady, Ericsson F. Bushnell, Fred H. Colvin, F. A. Halsey, Thomas T. Hoopes, Prof. D. C. Jackson, Joseph Keller, Fred R. Low, H. P. Merriam, H. F. J. Porter, Dr. M. I. Pupin, Dr. Elmer A. Sperry, Kirby Thomas, and F. A. Waldron.

Thomas Ewing, former commissioner of patents, is president, and Harrison W. Craver, librarian, United Engineering Societies Library, secretary.

Hydro-Electric Plant to Be Built on St. Regis River

A contract for the design and construction of a dam and power plant on the St. Regis River, near Potsdam, N. Y., has been awarded by the St. Lawrence Valley Power Co., a subsidiary of the Aluminum Co. of America. The dam, which will be of the Ambursen type, is to be 50 ft. high and 900 ft. long. A steel penstock 72 in. in diameter and approximately 2 miles long will extend from the dam to the power house. It is expected that work will be begun immediately.

U. S. Chamber Discusses Business Problems

Traffic, Transportation, City Planning Are High Spots at Three-Day Washington Meeting

(Special Correspondence)

That self regulation in American business is bringing about a condition which will result in fewer restrictions being imposed upon private enterprise and initiative through government regulation was the key-note in the address of John W. O'Leary, made at the opening session of the annual meeting of the Chamber of Commerce of the United States, held in Washington, May 2-4.

Labor and capital have entered upon a new era, in the opinion of speakers at the manufacturing session. America's ideal now is the application of the golden rule to labor relations. A striking feature of this session was the fact that twelve speakers emphasized the far-reaching benefits of prohibition legislation. No word was advanced in opposition to the law and no suggestion made for its modification.

Now that the fear of the Sherman Act has been removed from fact-finding, Judge Edwin B. Parker predicted that there would be little place for government regulation, as business now could regulate itself. While business may not act in concert to fix prices, or to limit competition unreasonably, or restrict production, Judge Parker declared that it is lawful to assemble facts and distribute them stripped of opinion.

At the domestic distribution session announcement was made of the plan to form a joint trade relations committee to seek out wasteful manufacturing practices. The Federal Trade Commission, Judge Parker said, has recognized the legality of gathering facts for the elimination of waste. The commission, he pointed out, is ready to pass upon rules of conduct formulated by industry and will help industry in protecting itself against those who indulge in improper practices.

Transportation Matters

What is good for the community is good for the railroads. What is not good for the community is not good for business. This statement was made by George D. Ogden, traffic manager of the Pennsylvania R.R., in the course of the discussion of new trends in transportation. The same philosophy, Mr. Ogden said, applies to the motor vehicle and to the use of the waterways. There is a growing demand for all forms of transportation, he said, and predicted that it would be a long time before transportation facilities would be entirely adequate.

A. J. Brosseau, president of Mack Trucks, Inc., held that the sphere of the railroad is the long haul. Trucks, he declared, are being confined more and more to the short haul, while the bus was held to occupy a definite but not thoroughly understood place in the transportation system. Transportation on the highways, in his opinion, is a great asset to the public and to the railroads as well.

W. L. Clause, the chairman of the board of the Pittsburgh Plate Glass Co., advocated the withdrawal of the government from the barge business and the greater use of waterways by privately-owned equipment. He cited figures in an effort to prove that the use of the waterways is highly beneficial to the railroads.

City Planning and Skyscrapers

City building so as to relieve both street congestion and transportation demands was the feature of the civic development session. John Ihlder, manager of the civic development department of the Chamber of Commerce, said that the success of the American people can be measured only in the ability of their business men to plan effectively for the future. Their vision must be exerted in city development so that it may proceed along sound economic lines.

The skyscraper is not a disease but a solution of business perplexities, it was contended by Harvey Wiley Corbett, New York architect. They reduce street congestion and enable business men to conduct operations in limited areas, he argued. With business hours growing shorter and the volume of business done growing larger, the skyscraper is as essential to efficiency as is the telephone or the automobile. To reduce building heights to seven or eight stories in the 42nd St. area of New York City would require one and one-half square miles of new territory and would so lengthen the lines of communication as to promote rather than decrease street congestion. In his opinion vertical transportation is easier to handle than horizontal transportation, particularly since automobiles take 400 sq.ft. of street area when traveling rapidly, 200 sq.ft. when they are moving slowly, and 100 sq.ft. when they are standing. Street capacities, he asserted, must be made to fit the capacity of building, even if double-deck or triple-deck streets may be made necessary.

Henry Curran, of New York City, spoke in opposition to the skyscraper. He holds that they make for congestion, particularly during rush hours, and that failure to control heights spoil the appearance of cities. Because of skyscrapers, he said, New York is faced with the necessity of putting all of its funds into new subway transportation facilities instead of building schools, parks and playgrounds.

Charles S. Lonsdale, of Kansas City, in reviewing the discussion, declared that the overwhelming opinion of those who took part in the meeting was against skyscrapers. The need for regulating the bulk of buildings was admitted by all, however, and there was general agreement that buildings should be separated from each other by stepping them back.

Centralization of all public health activities of the federal government, exclusive of those of the Army, Navy and Veterans Bureau, was favored. Control of toll bridges by public agencies was advocated. A committee of the Chamber of Commerce was authorized to consider suggestions for the control of flood on the Mississippi River. No action was taken on a large number of resolutions.

City Building Officials Discuss Progress

Building Departments and Codes—Fire Tests—Boston Licenses Building Foremen.

Building codes, the organization and administration of building departments and modern methods of fire tests for building materials were prominent subjects at the thirteenth annual meeting of the Building Officials' Conference, held at Chicago on April 26 to 29.

Salaries of building department officials and employees were discussed in a paper by William D. Guion, commissioner of buildings at Cleveland, Ohio, presenting tabulated statements for a series of cities of more than and less than 300,000 population. For building commissioners, the range was $3,600 (Louisville) to $8,000 (Chicago) for the larger class of cities, and $2,000 (Cranston, R. I.) to $7,000 (Hartford, Conn.) for the smaller class. For engineers of construction the range was $2,400 (Louisville) to $4,700 (New York-Manhattan) for the larger class, and $1,500 (Evansville) to $4,500 (Hartford, Conn.) for the few cities of the smaller class which have such a position. There was also a tabulation of fees for building permits of various kinds charged in a number of cities. The organization and duties of the building department at Washington, D. C., were described by Colonel Oehman, and the development of the Denver civic center, with its groups of public buildings, was outlined by J. T. Williams, city superintendent of buildings. In a general discussion it was claimed that city building departments do not function as they should, owing to inadequate budget appropriations and to lack of public support, a situation which calls for a campaign of publicity and public education.

Control of building operations as practiced at Boston was outlined in a paper by L. K. Rourke, building commissioner, and attracted special attention. Under the present regulations every piece of building construction, alteration or wrecking must be in the personal charge of a man licensed by a board of examiners. His name and address must be entered on the application for a permit, and if he is called away, the work must stop until another licensed man is put in responsible charge. These men are graded in several classes. In examining applicants, it was found that many men with large practical experience were deficient in the necessary technical knowledge. The board, therefore, instituted a school of instruction, one result of which was that a number of men applied for reexamination for a higher grade than that for which they originally entered.

A draft of a proposed uniform building code for the Pacific Coast was presented by J. H. Mackie, secretary of the Pacific Coast Building Officials Conference. This had been submitted to Frank H. Burton, past-president of the main association, who presented an extended analytical criticism. A report of the progress of the building-code committee of the U. S. Department of Commerce was presented by George N. Thompson, Washington, D. C., secretary of the committee. In regard to developments in building construction, a committee presented tentative specifications for fabricated steel joists, and a paper on arc welding for steel structures was presented by A. M. Candy.

As to fire protection and insurance, there were papers on the work of the National Board of Fire Underwriters, by Ira H. Woolson, consulting engineer for the board (whose sudden death is noted on p. 788) and the work of the Underwriters' Laboratories, by A. R. Small, New York. A visit was paid to the Chicago underwriters' laboratories to see fire tests and other investigations of building materials and equipment, following a visit to the laboratory of the Portland Cement Association. In line with the above papers was one by Wharton Clay, Chicago, reviewing the history and development of fire tests of building materials. Such tests were begun in Europe about 1889, and apparently the first fire test on full-size units in this country was conducted in Brooklyn in 1896 to determine the merits of cast-iron and steel columns. As a result of extended experience and investigation, tentative specifications for fire tests have been adopted by the American Society for Testing Materials, the National Fire Protection Association and the American Engineering Standards Committee.

A novel feature, supplementing the papers and committee reports, was a series of brief statements as to developments in industries tributary to building construction. These were made by men from associations representing the structual steel, portland cement, metal lath, common brick, reinforcing steel, tile, timber and building stone industries. Short addresses by Rudolph P. Miller, New York, and Major Lent, Cleveland, Ohio, described the behavior of buildings of different types in the Florida hurricane of last September. Mr. Miller emphasised the relative stability of structures in which good material and good workmanship were combined.

To indicate more clearly the national scope of the organization a change in name has been proposed and will be submitted to letter ballot. Suggestions were made also for closer co-operation with local or district associations, for preparation of a uniform building code, and for the appointment of a paid secretary in view of the increasing work imposed upon the office. Resolutions were passed referring these matters to the consideration of the executive board. Officers for the ensuing year include: President, H. E. Plummer, Portland, Ore.; vice president, W. L. Muehlstein, Madison, Wis.; secretary and treasurer, Fred W. Lumis, Springfield, Mass.

Power Plant to be Enlarged

The Ottawa River Power Co. a subsidiary of the Ottawa and Hull Power Co. has decided to install two additional units at the Bryson plant on the Ottawa River each having a capacity of 25,000 hp. This will give the plant a total capacity of 115,000 hp.

Earthquakes Discussed at Cambridge Meeting

John R. Freeman Reads Two Papers—City Commissions Advocated for Seismic Study

The annual meeting of the eastern section of the Seismological Society of America, held at Massachusetts Institute of Technology, Cambridge, May 4 and 5, had much of interest to the structural engineer. John R. Freeman read two papers, one being "Need of Better Seismograph Data for the Guidance of Structural Engineers." The present seismograph, he said, is "a plaything for superscientists and not a practical instrument for the use of structural engineers." His remark that when there is a severe earthquake the seismograph vibrations run off the paper reminded the hearer of how often anemometers break down during hurricanes. Mr. Freeman's other paper, "Data Available as a Basis for Earthquake Insurance" represented careful study and interpretation of a great amount of data he had collected. It suggested that on a scientific basis earthquake insurance should be but a small percentage of its present cost.

Prof. C. W. Brown, of Providence, in his paper "Basal Principles of Seismic Survey" advocated a commission to make a seismic survey for each city. A forward-looking community he said, should have a committee, the personnel of which should have a geologist, a seismologist, engineer, an insurance man, a representative from the public works department, and perhaps a Red Cross delegate. The survey should include the liability of the sources and distributary conduits of gas, water and electricity, and the communication channels of the area.

Prof. L. H. Young, of Harvard University, in a paper, "Vibration Problems in Industry" showed instruments he had devised for recording vibrations, and also the records made by them. These records need to be transposed for the structural engineer.

Prof. C. M. Spofford, of Massachusetts Institute of Technology, read a paper "Types of Structures Best Fitted to Resist Earthquakes" and illustrated with a number of lantern slides. Some of his conclusions from observation of earthquake damage are: that materials of low tensile resistance are to be avoided; that elasticity, continuity of structure, and lightness, are of more importance than thickness of walls or low height; that projections and heavy tile roofs are dangerous; and that cast-iron pipe systems may remain in service unless actual earth fissures occur.

Yale to Honor Designer of Bowl

A tablet in memory of Charles Addison Ferry, designer of the Yale Bowl, is to be dedicated at New Haven June 20. The tablet has been secured through the efforts of the Yale Engineering Association and is to be placed above one of the portals of the Bowl. Mr. Ferry was not only the designer of the Bowl but was also resident engineer during its construction. He died July 31, 1924.

A. G. C. Board Discusses Problems of Industry

A standard form of proposal for private building work which embodies the contract form of the American Institute of Architects was adopted at the spring meeting of the Executive Board of the Associated General Contractors of America held in Washington, May 2-5, inclusive. Many other subjects were discussed.

At the same time, the Advisory Board, the Presidents' Council and the Secretaries' Council of the Association met. It was decided to hold the fall meeting of these Boards and Councils at Birmingham, Ala.

The standard form of proposal seeks to fix responsibility more definitely as between the contractor and the architect, relieving the contractor of responsibility if he has followed the plans and specifications of the architect. The contractor is to guarantee against defects appearing within one year of the time the building is completed.

Considerable progress was made at the meeting as to policy toward equipment depreciation allowances at a conference between a committee and officials of the Internal Revenue Bureau. A schedule of standard time allowances for bidding was recommended to overcome the handicap of brief periods sometimes given in which to prepare bids.

There was considerable discussion of separate contracts, quantity surveys and other subjects.

Accident prevention and group liability insurance occupied several hours time. The employment of safety engineers by local chapters with regular meetings for the instruction of foremen and superintendents and regular inspections was generally favored. This plan is followed in some cities. It leads to lower liability insurance rates.

The mechanics lien law was discussed at length with the general expression that the present laws do not sufficiently protect the home builder. Advertising by chapters to warn the public to guard against application of mechanics liens was advocated in extreme cases.

The highway group discussed qualifying bidders before receiving bids, as is done now in Wisconsin. This system was considered a good one by most of the contractors. There also was discussion of the use of the standard questionnaire. Limited awards to contractors on their first bids for state highways, as is the system in Illinois, in order that a contractor may get acquainted with local conditions and laws before engaging heavily in highway construction also was discussed with varying points of view being expressed. Allan J. Parrish, president of the Illinois Association of Highway and Municipal Contractors, was held by his associates long beyond his allotted time in an explanation of cost of equipment ownership and depreciation. Figures gathered in Illinois from 25 of the largest contracting firms disclose that while the estimates on labor and material cost were close, the calculations as to equipment embodied in the bids varied from 6 to 40 cents per sq.yd. An intensive study of this subject is to be made by the contractors.

Random Lines

Practical Advice

"Charles Lathrop Pack, President of the American Tree Association, declared today that the lack of trees around the headwaters of streams that pour into the Mississippi River was responsible for the unusual floods in the Middle West and South, and urged immediate action to remedy the deficiency."—New York *Times*.

"William P. Willson of Ridgeway, Ont., member of the Ontario parliament from the Niagara Falls riding, voiced the opinion yesterday that the disastrous Mississippi floods are due, in part, at least, to the tremendous amount of water diverted from Lake Michigan through the Chicago drainage canal and eventually into the Mississippi."—Buffalo *Express*.

"Twenty years ago President Roosevelt's Conservation Commission engineers urged that Mississippi floods be abolished by storage reservoirs at the headwaters of the river and its main tributaries. The water so stored would not only be prevented from doing harm; it would do good, used to run hydro-electric plants and to provide water for all-year navigation." — New York *American*.

RELIEVE THE FLOOD SUFFERERS, BUT THE CURE LIES AT THE OTHER END

—Ding in the New York *Tribune*.

"Transform the Mississippi River itself into a series of elongated lakes, with a nearly uniform level of the water in flood or normal flow, instead of having a difference of more than 60 ft. at Memphis between minimum low water and maximum high water. Thus create at Vicksburg and Memphis a splendid harbor or bay, each capable of floating the entire American navy. . . . From the master dams and subsidiary works generate millions of hydro-electric horsepower from the mighty waters." — Herbert Myrick, Editor, New England *Homestead*.

"The government may be forced to turn large tracts of farm lands into forest preserves in the Mississippi Valley to prevent a recurrence of the disastrous flood that is now sweeping that region," Sam H. Thompson, President of the American Farm Bureau Federation, predicted.—*Associated Press*.

"A plan to prevent repetition of the Mississippi flood was offered yesterday by T. Kennard Thomson of 32 West Fortieth St., a consulting engineer. Briefly, Mr. Thomson's plan is to build three concrete river beds, each tapping tributaries of the Mississippi and running for thousands of miles to empty into the Gulf of Mexico."—New York *Times*.

"The French engineer J. Archer, asserts that he has discovered means to avert a recurrence of the Mississippi Valley floods. All he asks in return in the way of remuneration is a reduction in the French debt to America. The principle of the invention, is based on the employment of mechanical appliances increasing the flow of the river and thereby reducing the water level." —Wireless dispatch to New York *Times*.

Beach Preservation Association to Meet in Washington

The next meeting of the American Shore and Beach Preservation Association will be held May 23-24 in the National Academy, National Research Council, in Washington, D. C. Principal papers on the provisional program include "Legal Principles Affecting Riparian Land," Henry J. Gaede, special counsel, N. J. Board of Commerce and Navigation; "Revetment on the Mississippi River and its Possible Application to a Beach Subject to Wave Action," Major R. P. Howell, Corps of Engineers; "Sand-Tight Versus Permeable Groins"—a symposium, "The Harrison County, Mississippi, Sea Wall," Hobart D. Shaw, chief engineer, Harrison County Road Protection Commission; "Beach Preservation in Connection with Regional and City Plans," Thomas Adams, director of plans and surveys, Regional Plan of New York and Its Environs; and "The Relation of the Federal Government to the Association," Col. Earl I. Brown, Corps of Engineers, U. S. Army. There will also be a symposium on state participation in beach development.

Turner Company Celebrates Twenty-Fifth Anniversary

On May 6 the Turner Construction Co., celebrated the 25th anniversary of the granting of its charter by a dinner at the Biltmore Hotel, New York City, which was attended by some 275 of its major New York employees and by 25 guests. The dinner was the beginning of a series to be held at the headquarters cities of the company in the succeeding week. These other dinners are to be at Boston, Philadelphia, Atlanta, Buffalo and Chicago. At each dinner, the president, Henry C. Turner, and the senior vice-president, DeForest H. Dixon, the two founders of the firm, are to be present.

Personal Notes

ROBERT S. WOODBURN, JR., formerly of Rochester, N. Y., and assistant engineer for James McKinney & Son, has joined the organization of the Bethlehem Steel Co., Bethlehem, Pa., as an estimator in the bridge and fabrication department.

R. W. OREBAUGH, formerly city engineer, Manatee, Fla., has become a resident engineer on road work for the Vermont State Highway Department.

BOYD E. PHELPS, who has been chief of a survey party in road work for the Michigan State Highway Department, is now engaged as a project engineer, on road construction, for the Indiana State Highway Department and is located at Plymouth, Ind.

WILLIAM H. HARLAND, who has been senior signal engineer of the Bureau of Signals and Train Control Devices of the Interstate Commerce Commission, has been appointed director of traffic of the city of Washington, D. C., succeeding M. O. ELDRIDGE.

MURRAY M. MASON, formerly superintendent of construction for Stone & Webster, Inc., of Boston, is now connected with the Pennsylvania Water and Power Co., Baltimore, Md., as construction superintendent.

CLIFFORD M. STEGNER, architect and civil engineer, Cincinnati, Ohio, has been appointed building commissioner of the city of Cincinnati to succeed George Hauser, who has resigned.

R. G. ADAMS has joined the organization of Baker and Spencer, Inc., as of May 1, in charge of new contract department. His previous connections are: five years with McClellan & Junkersfeld, Inc., lately on contract negotiations and management; three years with the American Sugar Refining Co. on the design of the Baltimore refinery; two years in the Royal Flying Corps, and previous to the World War with the Babcock & Wilcox Co., the Bethlehem Steel Co., and the Combustion Engineering Corporation.

FRANCIS STEENO has been appointed city engineer for Green Bay, Wis., to fill the unexpired term of A. E. KRINGEL, who has resigned.

W. B. HALL was recently elected to the position of city engineer for Oconto, Wis.

J. DE N. MACOMB, office engineer of the Atchison, Topeka & Santa Fé Ry., has taken a position with the Inland Steel Co. as assistant to the vice-president in charge of railroad sales. His office is at 38 So. Dearborn St., Chicago.

B. L. THORNE, of the coal mines branch, Department of Natural Resources, Canadian Pacific Ry., Calgary, Alberta, has been elected president of the Association of Professional Engineers of Alberta.

G. D. O'CONNOR, who has been assistant to T. S. Scott, city manager and engineer of Niagara Falls, Ont., for a considerable time, has joined the engineering staff of Roger Miller and Sons, at Niagara Falls.

L. E. ANDREWS, formerly division construction engineer with the New Jersey State Highway Department, with headquarters in Newark, is now with the Portland Cement Association as engineer in charge of design and control methods applied to concrete mixtures and is located in the New York District.

R. C. RUTTER, who was resident engineer on construction of Lake Pleasant dam for the Maricopa County Municipal Water Conservation District No. 1, Phoenix, Ariz., has gone into highway work in the Harris County, Texas, highway department, and is located at Houston, Tex. Prior to his work in Arizona, Mr. Rutter was consulting engineer in association with Col. John R. Fordyce, at Hot Springs, Ark.

Engineering Societies

Calendar

Annual Meetings

SOCIETY OF INDUSTRIAL ENGINEERS, Chicago, Ill.; Annual Meeting, Chicago, Ill., May 24-27, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS, Chicago, Ill.; Annual Meeting, Washington, D. C., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The Detroit Engineering Society at its April 16 meeting elected as officers the following: President, William F. Zabriskie; vice-presidents Charles J. Peck and J. P. Hallihan; and secretary-treasurer, F. A. Kimmich. Hawley S. Simpson, traffic engineer for Detroit, spoke before the society at a dinner May 6 on the subject of traffic signals and their enforcement.

The Conference on Steel Treating will hold its first meeting at Purdue University, Lafayette, Ind., May 26 and 27. This conference has been arranged by the Engineering Extension Department of Purdue University in response to requests which had been received asking for a conference on the problems of steel treating. The program will include addresses by speakers of national reputation and demonstrations of treating processes and tests, and there will be inspection trips. For programs address Prof. W. A. Knapp, of the Engineering Extension Department, Purdue University.

The Providence, R. I., Engineering Society announces that on May 24 Col. F. F. Longley, of the Lock Joint Pipe Co., Ampere, N. J., will deliver an address on the subject, "The New Water Mains for Providence."

Obituary

COL. J. B. CAVANAUGH, Corps of Engineers, retired, who directed the work of building the Lake Washington canal from Lake Washington to Puget Sound at Seattle, Wash., and who during the World War was in command of the 18th Engineers Railway, died April 26 at Coronado, Calif., of pneumonia, aged 57 years. Colonel Cavanaugh was born in Illinois. His family moved to Olympia, Wash., and in 1888 he was appointed to West Point from the state of Washington. After graduation he was detailed to the Engineers' School of Application, a preferential assignment, and graduated therefrom in 1895. He spent a year at Detroit and then for four years was stationed at Mobile, Ala., on river and harbor improvements and fortification work. In 1900 he was ordered to the Philippine Islands on road and other construction and the next year he was assigned to Fort Leavenworth, Kan., followed by a return period in Alabama, at Montgomery. In 1907 he was appointed to the office of assistant to the Chief of Engineers at Washington, D. C., and after four years in that position, in 1911, he was placed in charge of the Puget Sound District in the state of Washington, where, among other things, he designed the government locks and brought to a successful completion the Lake Washington canal. During the World War, he organized the 18th Engineers Railway a Pacific Coast organization, one of the first regiments to reach France, and his war services won him the Distinguished Service Medal. After his return from France he was district engineer of the Nashville, Chattanooga and Florence districts. After his retirement, several years ago he represented an organization with iron holdings in Minnesota.

A. W. CAMPBELL, chief commissioner of the Canada Highways Commission, Department of Railways and Canals, Ottawa, Ontario, died May 9 after a short illness; he was 63 years of age. Mr. Campbell was for thirty years identified with the development of good roads in Ontario, from the time when he was city engineer of St. Thomas and editor of *The Municipal World*. Besides the road activities which he promoted, he wrote many technical reports which attained considerable importance. He was honorary president of the Canadian Good Roads Association.

FRANK J. HUBBARD, civil engineer, died at his home, Plainfield, N. J., Feb. 23 last, at the age of 59 years. Mr. Hubbard was for 13 years county engineer for Union County. He was twice engineer of the borough of North Plainfield, covering a period of 10 years, and was engineer for the borough of Dunellen for 10 years, which position he held at the time of his death. Quite recently he had completed plans for a proposed viaduct between the municipalities of Plainfield and North Plainfield.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Concrete Road Yardage

For April the square yardage included in concrete pavement contract awards according to the Portland Cement Association was: 10,264,336 for roads; 4,931,954 for streets; and 285,924 for alleys; or a total for the month of 15,482,214 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1927

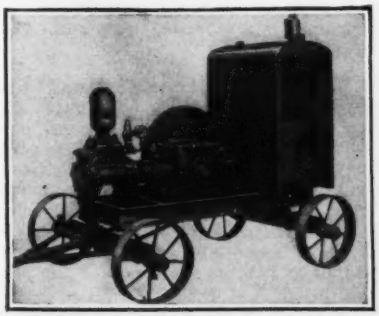
Month	Roads	Streets	Alleys	Total All Classes
Jan.....	2,656,118	1,504,059	75,352	4,235,529
Feb.....	2,336,031	1,935,262	119,382	4,390,675
March...	5,134,974	3,866,102	298,667	9,299,743
April.....	10,264,336	4,931,954	285,924	15,482,214
Totals.	20,391,459	12,237,377	779,325	33,408,161

New Developments

High Pressure Piston Pumps of Self-Oiling Design

A new line of 1, 2 and 3 cylinder piston pumps for general contracting and road building work recently has been introduced by the Novo Engine Co., Lansing, Mich., which has the important characteristic of being self-oiling. No grease cups are used, all gears running in a bath of oil, the pumps being of totally enclosed, horizontal type. The illustration shows the Duplex double acting pump. It may be powered with either a one or two cylinder gasoline engine. Electric motors are available if desired.

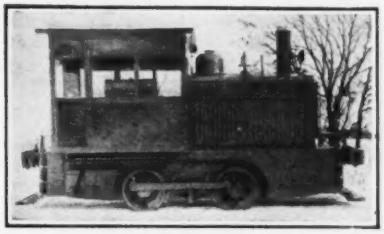
The Triplex pump of similar design is particularly for road builders' use



being the proper size to operate with a 27-E paver. It has a capacity up to 70 g.p.m. at 500 lb. pressure and is powered with a Novo 25 hp. four cylinder engine mounted on a steel truck. As in the other unit, all gears, pinions, crossheads, pins and bearings are enclosed in an oil tight case and automatically lubricated. The oiling system is designated as Fluid-Oiled and is of special design. The pump crank shaft gear runs in the oil reservoir. When revolving it brings the oil to a small gear at the top of the case. This small gear is the fundamental part of the lubricating system. It is the only moving part in the system and has an arrangement of oil ducts in its teeth. These teeth are hollow and discharge oil from either end with considerable force. The discharged oil is caught in troughs and led to the crosshead pin and to all bearings.

Gasoline Locomotive Built in a 30-Ton Size

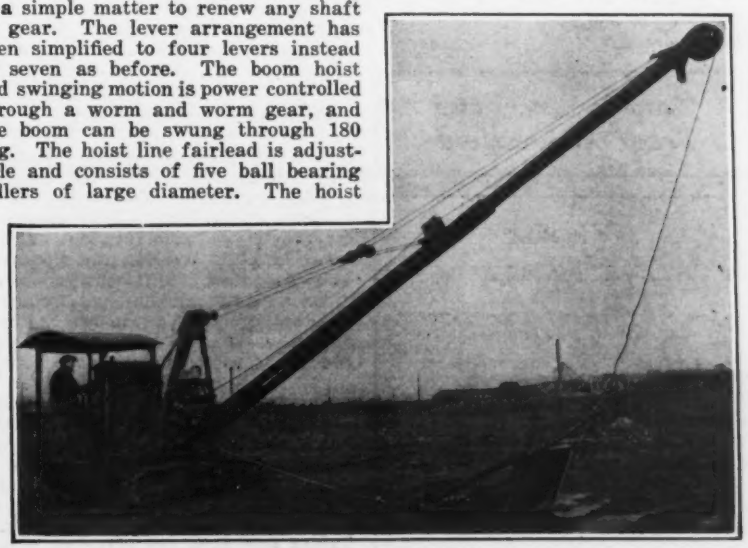
There was recently purchased by the Dupont Rayon Co. from the George D. Whitcomb Co., Rochelle, Ill., a 30-ton gasoline locomotive claimed to be one



of the largest ever built except for experimental purposes. It is powered with a 6-cylinder 6½x7 Beaver engine, rated 160 hp. at 1,000 r.p.m. It has a draw bar pull of 17,500 lb. on low gear without sand.

Backfiller Uses Unit Cast Steel Construction

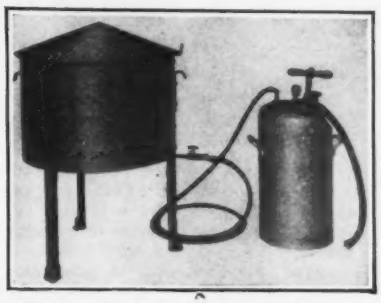
The new model backfiller recently introduced by Harnischfeger Corp., Milwaukee, Wis., is designed along the same lines as are its new excavators being built on a base of unit cast steel. All shafting is in the same plane, making it a simple matter to renew any shaft or gear. The lever arrangement has been simplified to four levers instead of seven as before. The boom hoist and swinging motion is power controlled through a worm and worm gear, and the boom can be swung through 180 deg. The hoist line fairlead is adjustable and consists of five ball bearing rollers of large diameter. The hoist speed is 300 ft. per minute while the dragline speed is 150 ft. per minute. As a clamshell, the machine handles a ¾-yd. bucket. As a crane it has a lifting capacity at 15 ft. of 2,000 lb. The boom is adjustable from 22 to 30 ft. in 18-in. steps. Other important advantages claimed for this new model are its great stability and rugged construction.



Oil Burning Salamanders

For use on winter construction the ordinary type of coke burning salamander has been replaced in some places by equipment using oil for fuel.

The accompanying photographs show two designs of oil burning salamanders manufactured by the Macleod Co., Cincinnati, Ohio. The oil burners are mounted in heating chambers of a size arranged to give the maximum amount of radiation.



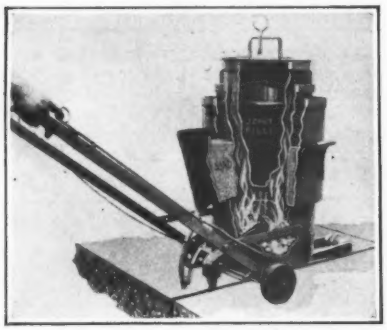
The oil tank supplying the burner is arranged with a pressure gage, complete fittings and a combination oil and air pump. The tank may be re-

plenished with oil without stopping the burner and with entire safety.

One illustration shows the unit mounted on a small stand fitted with two handles so it can be easily moved about. The other illustration shows the heating chamber mounted on legs and the burner connected by a hose. With this arrangement the burner and tank can be moved away from the heating chamber and used for other purposes.

Rapid Joint Pouring Machine

A new joint pouring machine has recently been developed by the Heltzel Steel Form & Iron Co., Warren, Ohio, which heats, pours and sands. It is so constructed that the fire is between the joint filler compartment and the sand compartment as shown in the accompanying illustration. The filler discharge pipe passes through the fire box maintaining a uniform heat and causing the discharge nozzle to deposit the filler at a uniform temperature; a needle valve regulates the flow.



Inasmuch as the filler is heated at the time of pouring it is said to penetrate to the bottom of the joint.

In operating the machine no bridging is necessary and the broad tread wheels do not mar the concrete. A pilot wheel running in the joint insures perfect alignment. The sanding compartment is recommended for use on grades to prevent the filler from flowing out but is not necessary on semi-level roads.

A fire box is provided for any kind of fuel or is equipped with oil burner when desired.

Manufacturers and Trade Associations

Calendar

Annual Meetings

NATIONAL LIME ASSOCIATION, Washington, D. C.; Annual Business Meeting, White Sulphur Springs, W. Va., May 17-18-19.

RAIL STEEL BAR ASSOCIATION, Chicago; Semi-annual meeting, New York City, May 20.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

NATIONAL ASSOCIATION OF MANUFACTURERS; Annual meeting, Chattanooga, Tenn., October 25, 26 and 27.

Business Notes

CHARLES E. PROUDLEY has been added to the staff of the National Sand and Gravel Association as joint assistant to the executive secretary and to the director of the engineering and research division. Mr. Proudley worked in the United States Bureau of Public Roads from 1915, with the exception of field artillery service during the World War, until the present appointment. From 1921 to 1925 he was in charge of testing and research on non-bituminous materials and later in charge of the concrete research laboratory with the title of assistant engineer of tests.

WM. H. RHODES, maintenance engineer with the Oklahoma State Highway Commission for the past three years, has resigned and taken a position as manager of the Southern District of the Asphalt Association with headquarters at New Orleans, La. Mr. Rhodes formerly was with the Bureau of Public Roads, and was later retained by the Louisiana State Highway Commission, where he organized the maintenance department.

JOHN F. METTEN, previously vice-president and chief engineer, William Cramp & Sons, has become vice-president in charge of marine engineering for the American Brown Boveri Electric Corp., New York City. This change follows the announced withdrawal of William Cramp & Sons from the shipbuilding industry.

New Publications

Material Handling—JEFFREY MFG. CO., Columbus, Ohio, has devoted a new 36-p. catalog No. 437 to its different types of equipment for handling stone, gravel, sand, cement, and similar materials. The equipment illustrated and described includes elevators (both bucket and arm types), conveyors (bucket, apron, pan, drag chain, spiral and belt types), power shovels, revolving screens, sand settling tanks, pulverizers, chains, sprockets, gears, portable loaders, and coal and ash-handling equipment.

Arc Welding—GENERAL ELECTRIC CO., Schenectady, N. Y., has prepared a 12-p. booklet on the subject of automatic arc welding. The company's different type machines for various kinds of plate welding are illustrated and described. Information is also given on automatic welders for use in building up such equipment as worn car-wheel flanges, locomotive guide rods, and automobile rear-axle housing.

Cork Roof Insulation—UNITED CORK COS., Lyndhurst, N. J., has published a new booklet on the insulation of roofs of industrial plants in which is described the use of cork board which may be installed directly upon practically any type of roof construction. Tables and data are given on a large number of different types of roof setting forth their resistance to and transmission of heat.

Paving Joint Machine — FLEXIBLE ROAD JOINT MACHINE CO., Warren, Ohio, recently issued a catalog describing the Flex-Plane system of longitudinal and transverse joint construction for concrete roads. This system was used on the U. S. Bureau of Roads experimental job on the Lee Highway in Virginia. The catalog contains illustrations of the use of equipment in addition to the text description.

Sewage Pumps—YEOMANS BROTHERS CO., Chicago, in a recent bulletin, No. S-6000, describes its non-clogging sewage pumps, both horizontal and vertical types. Cross-sectional drawings, illustrations, dimensional tables, and installation drawings are given.

Valves—ROSS VALVE MFG. CO., INC., Troy, N. Y., has issued a new catalog, No. 27, in which are given complete data on the company's pressure regulating valves, hydraulic booster pumps and feed water filters.

Galvanized Iron Roofs—AMERICAN ROLLING MILL CO., Middletown, Ohio, has just issued a 56-p. booklet entitled "Galvanized Iron for Roofs and Roof Drainage." The booklet contains general information and suggested specifications for galvanized iron roofs and roof drainage on all types of buildings. A special section is devoted to industrial buildings and includes detailed drawings. Reference tables are included giving data on wood beam safe loads, dead and live-loads for various types of roofs and specifications for flat and corrugated galvanized iron sheets.

Road Machinery—Good Roads Machinery Co., Inc., Kennett Square, Pa., has issued an 8-p. bulletin, entitled "Everything for the Road Maker." The bulletin consists of illustrations and brief descriptions of such equipment as pressure distributors, road rollers, maintenance graders, rock crushing plants, car unloaders, road drags, etc.

Spiral Pipe—NAYLOR SPIRAL PIPE CO., Chicago, Ill., in a new 16-p. catalog, describes its spiral lock-seam pipe. Information and photographs are given of the pipe in use in various industries and specifications are given for flanged pipe, pontoon pipe, pipe with bolted connections or with slip joints. Complete information is also given on standard fittings for use with the pipe.

Weights of Hardwood — HARDWOOD MANUFACTURERS INSTITUTE, Memphis, Tenn., has issued a booklet giving in detail tables on the estimated weight per cu.ft. of hardwood at a given thickness and moisture content. Weights are given for thicknesses ranging from ⅛ to 19/16 in. and for lumber of green material and of moisture contents of 10, 12, 14, 16, 18 and 20 per cent. Such woods as ash, beech, cottonwood, butternut, dogwood, cypress, elm, hemlock, hickory, locust, maple, oak, poplar, sycamore, walnut and willow are tabulated.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Is Labor Receiving Too Large a Proportion of Construction Cost?

Materials Forming Increasingly Smaller Percentage as Shown by Study of Six Different Types of Buildings

By F. E. BARNES
Building Valuation Engineer, New York Central Lines

In reading this article it should be borne in mind that without labor there is no value at all. The raw materials, to attain to value, must be mined, quarried, manufactured, transported and put in place—all labor costs. Mr. Barnes discusses the growing cost proportion of labor in the building trades—the men who put the materials in place. He deals with the varying relationship of two cost elements: (1) prices of building materials and (2) cost of building labor.

IN 1890 erection labor was receiving about 30 per cent of the total cost of buildings, while in 1926 labor received approximately 42 per cent. The increase has not been constant, but has been attended by a series of ups and downs with the ups considerably larger than the downs. The accompanying chart shows three trend lines. No. 1 gives the increased cost in building material and is from data furnished by the U. S. Department of Labor; the only change being in using the average cost for the years 1910 to 1914 inclusive as 100 per cent, instead of using the year 1913 as a base. No. 2 gives the average increase of building labor. This curve was prepared by taking the average wage paid to twenty-one of the building trades in fourteen of the principal or large cities of the eastern half of the United States, the average price for the years 1910-1914 being treated as 100 per cent. No. 3 shows the proportion which erection labor received of the total cost of a group of buildings. The proportion was determined by taking the weighted average percentage which labor received for the following group: a frame passenger station, a brick passenger station, a modern office building, a frame shop building, a brick shop with wood framing, and a brick shop with steel framing.

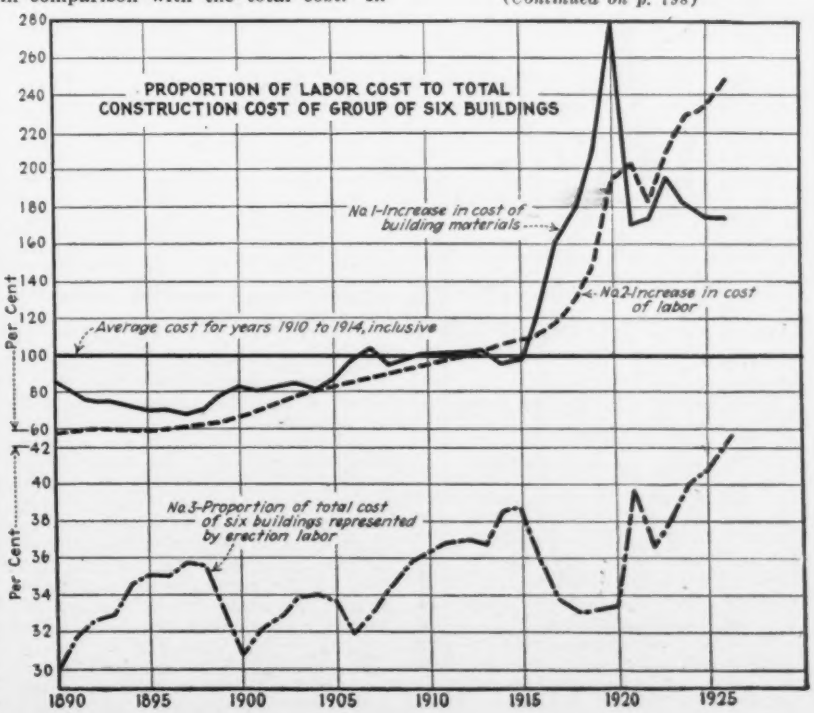
The method followed in preparing trend line No. 3 was practically the same as that followed in preparing the chart entitled "Proportion of Labor Cost to the Total Construction Cost of Building," as shown in *Engineering News-Record*, issue of Nov. 11, 1926, p. 811. The differences that appear in the two curves are caused by including all of the erection labor instead of that of the general contractor only, as in the issue of Nov. 11, and by the addition of the other five types, which has been done to make the case more comparable with average construction work. This curve is carried back to 1890, while the one previously published started with the year 1900.

Even a cursory inspection is sufficient to make it evident to any one that labor has been receiving a constantly increasing proportion of the cost of construction. There is, however, a certain relationship existing between the three trend lines that is worthy of close study, and this relationship is what I wish to point out.

From 1890 to 1898 trend line No. 2 shows that labor was receiving practically a uniform wage, while trend line No. 1 indicates that building material was constantly coming down with the result that trend line No. 3 shows a rapid rise. In other words, labor was receiving year by year a larger proportion of the cost of construction, even though there was no more money in the laborer's weekly pay envelope, yet he was getting the equivalent of a raise, in comparison with the total cost. In 1899 and 1900 building material took a sharp advance, while labor received but a slight increase with the result that labor's proportion dropped back to about the same point where it had been in 1891.

From 1900 to 1904 trend line No. 1 shows that the price of building material was practically at a standstill, while labor received a gradual increase, causing another slight advance in labor's proportion of the total cost. From 1905 to 1907 building material received a decided advance, which put a crimp in the proportion received by labor. From 1908 to 1915 the price of building material was practically at a standstill, while labor received a constantly increasing wage. The result is indicated by the ascending trend line No. 3. This gave labor in 1915 about 38.8 per cent, which was the largest proportion of the entire cost which it had ever received up to that time. From 1915 to 1918 building material advanced far more rapidly than did labor with the result that labor's proportion dropped, even though there was an increase in the rate of wages each year, yet labor was receiving a diminishing ratio of the entire cost. During the years 1919 and 1920 labor and building materials were both advancing at the same rate; hence trend line No. 3 becomes nearly a horizontal line, indicating that labor was just holding its own. In 1921 labor received a slight advance, while building material received a heavy cut, with the result

(Continued on p. 798)



Weekly Construction Market

PRICE changes of the last two weeks were largely advances and most of these occurred in Western cities. The materials affected, comprise reinforcing bars, structural rivets, Douglas fir timbers, and common lump lime. Linseed oil also developed a strong upward price movement in all of the principal industrial centers.

It is evident that the price firmness in question, is due to sustained demand for new construction and is in no way connected with scarcity of materials, growing out of conditions prevalent in the flooded areas of the Mississippi valley. Minor advances such as those cited are seasonal and of insufficient weight to affect the general downward trend in building materials started at least eight months ago. Finished steel (as a class), pig iron, scrap, coke, pipe, and wire products are all working gradually to lower price levels.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.87½	$3.00	—$3.00	$3.80
Structural rivets, 100 lb.	5.00	3.80	4.75	3.50	3.75	4.65	5.00	+5.00	7.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	2.75	2.30@2.50	2.87½	3.87½	2.95	+3.00	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	48%	41%	42@53.8%	48%	37.83
Cast-iron pipe, 6 in. and over, ton	48.60	42.00	54.00	46.20	48.50	56.50	56.00	55.00	62.50
Concreting Material									
Cement without bags, bbl.	2.35@2.50	2.35	2.05	2.05	2.22	2.85	2.51	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	—1.70	1.65	1.90	1.80	1.25	1.50
Sand, cu.yd.	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	59@61	34.00	56.00	40.50	+39.75	+34.25	27.00	23.00	50.00
Lime, finishing, hydrated, ton	18.20	22.00	19.00	20.00	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.50	1.82	1.50	1.70	2.70	+1.70	2.80	10.00
Common brick, delivered, 1,000	19@20	12.00	14.10	12.00	13.75	9@10	14.00	14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	076	.072	.085	.....	.10	.10
Hollow partition tile 4x12x12, per block	.1027	.0895	.112	076	.072	.085	.108	.09	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	+ 87¾	.89¼	1.10	+ 90	+.97½	+1.10	.89	.95	1.05
Common Labor									
Common labor, union, hour	.90⅛	.30	..	90	.....	.....	60	.62½	.....
Common labor, non-union, hour	.....	.25	30@.50	....	.45@.60	—.31¼@.50	.50	.62½	+ 30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel), shapes and rivets delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅛c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b. Fir is quoted instead of pine. Reinforcing bars (billet steel) and rivets f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) and rivets at warehouse in carload lots; shapes, less-than-carload lots. Steel pipe under 3-in., 51% off list.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of May 5, the next on June 2.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) rivets and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) and rivets, f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) carlots; shapes and rivets, less-than-carload lots.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes and rivets, less-than-carload lots.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) carlots; shapes and rivets, l.c.l.

Montreal quotes on fir lumber. **Sand,** stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.078). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, in carload lots; rivets, l.c.l.

Is Labor Receiving Too Large a Proportion of Construction Cost?

(*Concluded from p. 797*)

that the labor ratio shows the largest increase ever received in any one year. In 1922 the reverse took place. Building material got a small advance and labor received a cut, so that by the end of 1922 labor had lost about one-half of what it had gained in 1921. From 1923 to date building material has been coming down by decreasing amounts each year, while wages in the building trades have been increasing by generous amounts as indicated by trend lines No. 1 and No. 2.

In making this study no allowance has been made for any decrease that may have occurred in the efficiency of labor nor for bonuses, that in many cases amounted to a substantial sum. If these items were taken into account, labor's proportion would go even higher. The percentages as given are figured on the entire cost of the buildings, including the contractor's overhead and profit.

One cannot help but wonder how long labor will continue to receive an ever increasing proportion of the cost of construction. It requires no special argument to convince any one that it cannot continue indefinitely, as ultimately, labor would receive 100 per cent and material nothing. But when will the change come and what will bring it about? Will it be with a sudden wrench or will it come gradually as water in a sluggish stream seeks its level? If history repeats itself, a change is about due and should take place within one or two years. As I have already pointed out this can be brought about by either an advance in the price of building material, or a decline in the present rate of wages.